

Compressed Air

JULY 1955

Magazine



PHOTO, COLORADO STATE HIGHWAY DEPARTMENT

TUNNEL THROUGH
1903 SNOWSLIDE
Like the U.S. mail, the old
horse-drawn stagecoach
always got there

VOLUME 60 • NUMBER 7

NEW YORK • LONDON

COPPUS

"BLUE RIBBON"

VENTILATORS

Used in wide variety of applications throughout industry

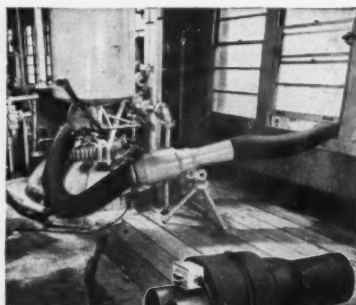
Improve workers' safety ... health ... comfort ... efficiency



VANO DESIGN "A" VENTILATOR is used here during repairs to a chemical still. This type ventilator is used to ventilate tanks, tank cars, drums, vats, underground cable manholes, pipe galleries, air-plane wing compartments, fuselages and other confined places. Uses 8" diameter flexible canvas tubing ("Ventube").



VANO DESIGN "B" VENTILATOR here discharges welding fumes from double-bottom compartment in naval vessel under construction. Large volume of air handled quickly expels fumes and results in good ventilation. Vano Design "B" can pass through opening only 14" in diameter. Uses 8" diameter flexible canvas tubing ("Ventube").



VANO DESIGN "C" VENTILATOR here withdraws fumes from a reactor kettle. This ventilator can be furnished with 8" suction inlet for 8" non-collapsible suction tubing — or multiple inlet nozzles for 5", 4", and 3" suction hose. The discharge may be connected to 8" "Ventube." Capacities furnished on request.



NO. 2 AEROPLANE HEAT KILLER here directs cool, fresh air on worker in drop forge plant. Heat killers restore workers' efficiency by providing extra ventilation in the hot months, or on any job where workers are continually or periodically required to work in excessive heat. Available in two types, three sizes in each.



VENTAIR DESIGN TE-4 VENTILATOR Gasoline Engine Driven, here delivers air into underground manhole. These ventilators provide fresh air to men in confined places, promoting safety, comfort, and increasing efficiency. Ideal where no electric current is available. Delivers 1700 CFM of fresh air. Uses 8" diameter flexible canvas tubing ("Ventube").



PORTAIR NO. 4 BLOWER EXHAUSTER exhausts fumes resulting from soldering, welding, tank coating, is also used in ventilating small tanks. It is designed to permit attachment of 4" flexible metal hose. Capacity: 425 CFM free air.

ATTACH THIS COUPON TO YOUR COMPANY LETTERHEAD

COPPUS ENGINEERING CORPORATION, 207 PARK AVENUE, WORCESTER 2, MASS. Sales offices in Thomas' Register. Other "Blue Ribbon" Products in Chemical Engineering Catalog, Refinery Catalog, Best's Safety Directory and Mining Catalogs.

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- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes
- ☐ in aeroplane fuselages, wings, etc.
- ☐ on coke ovens
- ☐ on steam-heated rubber processes

☐ on boiler repair jobs

COOLING:

- ☐ motors, generators, switchboards
- ☐ wires and sheets
- ☐ general man cooling

- ☐ around cracking stills
- ☐ exhausting welding fumes
- ☐ stirring up stagnant air
- ☐ wherever men are working or material is drying
- ☐ drying of walls, sheets, etc., after treated with coating material

Name

Company

Address

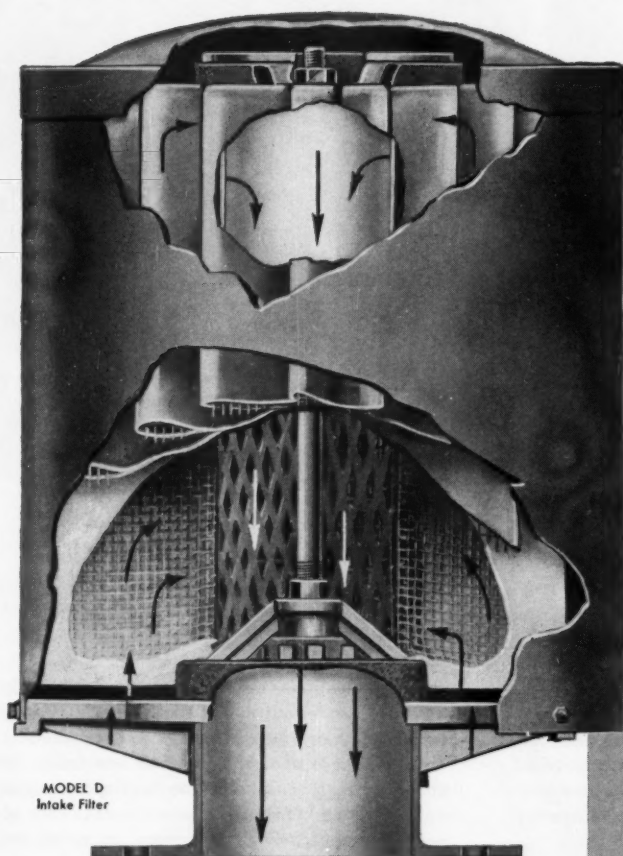
City Zone State

Write here any special ventilating problem you may have {

STAYNEW

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HELP YOUR EQUIPMENT **STAY NEW!**



MODEL D
Intake Filter



Representatives in Principal Cities

DOLLINGER

CORPORATION

7 Centre Pk., Rochester 3, N. Y.

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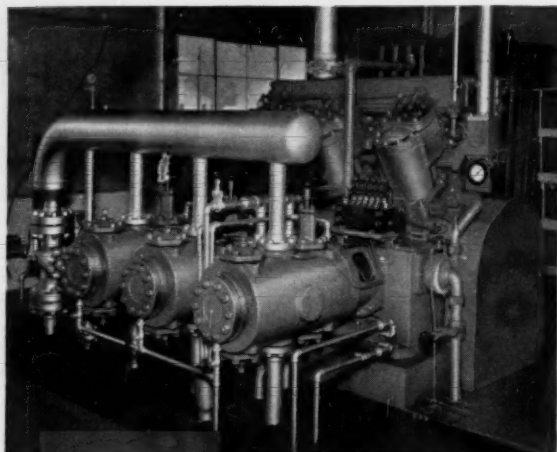
- Efficiency Actually Increases With Use.
- Efficient Over a Wide Range of Loads.
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- No Oil Carry-Over.
- No Oil Blow-Out On Free Air-Unloading Compressors.
- Model DS Silencer Filters Are Available Where Noise Is a Problem.
- When Cleaning Is Indicated, a Brush or Simple Vacuum Cleaning Tool Is All You Need.

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FOR EVERY
INDUSTRIAL NEED

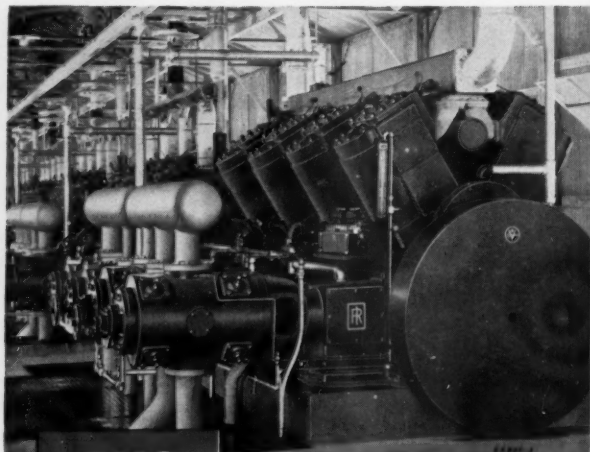
Be sure your gas have these two



JVG

110 to 220 hp

Ingersoll-Rand JVG gas-engine compressor installed on a natural gas pipe line for recompression from 350 psi intake to 410 psi discharge.



SVG

330 to 660 hp

Bank of five I-R gas-engine compressors in gas booster service. SVG unit in foreground compresses natural gas from 47 to 400 psi.

From 110 to 2000 hp, these I-R units have two advantages that set them apart from all others!

A gas-engine compressor is really two machines in one. A gas engine to provide the power and a compressor to do the work. In each of these equally important functions, Ingersoll-Rand has, over the years, pioneered and perfected basic types of construction that are common to their entire line of gas-engine compressors.

1. Four-cycle Flexibility

Every I-R unit utilizes a V-type four-cycle engine. That's because only the four-cycle engine assures stable and dependable operation over the widest range of speeds and loads. It delivers smooth power all the way from half speed to full speed and from no load to full load, or any combination within this range. In

many applications this four-cycle flexibility of loading is a vital necessity to meet the load swings and speed variations that are a part of normal operation.

Even where speeds and loads are fairly constant under normal conditions, the four-cycle engine provides a valuable margin of safety to take care of unexpected or emergency fluctuations in speed and load without danger of stalling out.

2. Compressor cylinders engineered to the job . . . using valves from the most complete line available.

Every I-R gas-engine compressor uses compressor cylinders and valves that are tailored to meet the

COMPRESSORS

CONDENSERS

AIR & ELECTRIC TOOLS

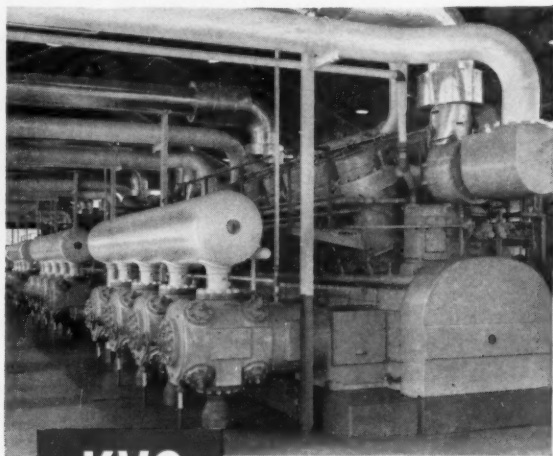
engine compressors outstanding features



KVG

880 to 1,320 hp

Six Ingersoll-Rand KVG gas-engine-driven compressors installed on a large Southwestern transmission line.



KVS

2,000 hp

Four of seven Type KVS turbo-charged gas-engine compressors installed in a large gasoline plant. Each unit compresses process gas from 0 to 800 psi.

precise requirements for each application. Their worldwide reputation for lasting dependability and reduced maintenance is the result of more than 77 years of specialized experience in designing and building air and gas compressors.

Ingersoll-Rand valves are the most dependable available. Complete records from many pipeline compressor stations show that I-R valves run for many months without forcing a compressor shutdown. And Ingersoll-Rand has valves to cover the entire range of operating requirements for any pressure, any type of gas . . .

more types and sizes of compressor valves than any other manufacturer.

These two basic advantages . . . four-cycle flexibility and the extra dependability of job-engineered I-R compressor cylinders and valves . . . add up to long-range savings in operating and maintenance costs.

Your nearest Ingersoll-Rand representative will be glad to give you all the facts on any type of unit. His wide experience in the selection, application and installation of this equipment can save you time and expense all along the line.

Ingersoll-Rand

6-262

11 Broadway, New York 4, N. Y.



PUMPS

• ROCK DRILLS

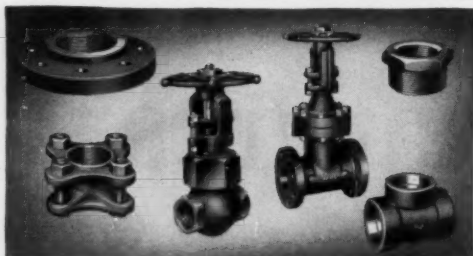
• GAS & DIESEL ENGINES

JULY, 1955

Circle 3A on reply card

Adv. 5

Designed for today's *Tough* service demands

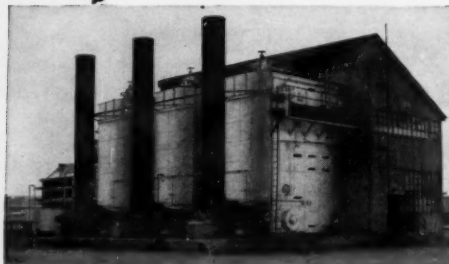


DROP FORGED VALVES AND FITTINGS FOR TOUGHNESS AND TROUBLE-FREE SERVICE

Drop forged from carbon and alloy steels, Vogt valves, fittings and flanges will safely handle liquids and gases at high pressures and high temperatures in power plants, chemical plants, petroleum refineries, etc. The complete line includes flanged, screwed and socket weld end globe, gate and check valves—ells, tees, and crosses—couplings—bushings—plugs—unions—flanges and flange unions—and welding heads.

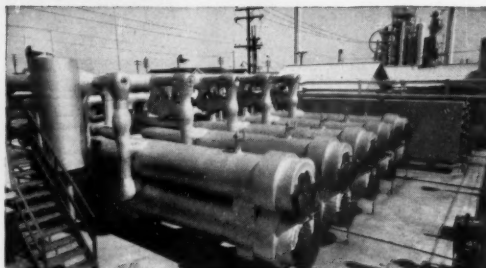
MODERN STEAM GENERATORS

Vogt steam generators are designed to give maximum rating in a minimum of space, with high efficiency and low maintenance expense. Bent tube types and straight tube, forged steel sectional header types to burn solid, liquid or gaseous fuels meet every power, process or heating requirement.



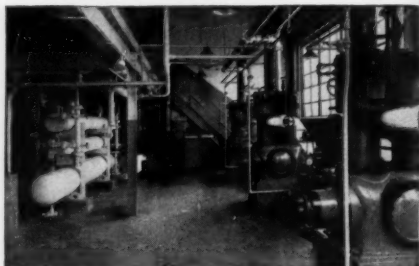
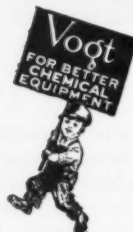
PROCESS EQUIPMENT FOR EVERY SERVICE

Vogt constructs process equipment in wide variety to all Codes. Stills and towers, oil chillers, crystallizers, heat exchangers, molding machines, etc., serve in the manufacture of oils, greases, 100 octane gasoline, synthetic rubber, chemicals and related products around the world.



SPECIAL MATERIALS COMBAT CORROSION AND PRODUCT CONTAMINATION

Our modern shops produce a wide variety of equipment from special metals and alloys to fight corrosion and product discoloration or contamination. Fabrication procedures insure that corrosion resistant properties of welds will match that of the materials used to construct the equipment.



Vogt

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St. Louis, Dallas, Charleston, W. Va.

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More than 70 years of engineering and manufacturing experience is incorporated in Vogt refrigerating and ice making equipment. Absorption Systems, Compression Systems, and Tube-Ice Machines in a wide range of capacities serve industrial and processing plants, and institutions, here and abroad.



ON ALL NEW RELIANCE A-C. MOTORS

All new Reliance A-c. Motors provide these two essentials to trouble-free operation in hazardous or corrosive atmospheres . . .

POSITIVE PROTECTION

A pure neoprene gasket encloses each lead wire with an individually molded pressure knob. This gasket forms a positive protective seal between the motor frame and the corrosion-proof, cast iron conduit box.

POSITIVE IDENTIFICATION

Numbers on the pressure knobs and lead lugs correspond with a numbered wiring diagram on the stainless steel nameplate. Identification for installing or rewiring is positive and easy.

Another Reliance engineered development to assure industry a Totally-Protected, Precision-Built Motor!

Get in touch with your nearest Reliance sales office or distributor, or write for bulletin B-2401. *Reliance Electric & Engineering Co., 1118 Ivanhoe Road, Cleveland 10, Ohio; Canadian Division — Welland, Ontario.*

B-1497

RELIANCE ELECTRIC AND ENGINEERING CO. ●



Using stopper, new hole is started at The New Jersey Zinc Co.'s Sterling Mine. Bethlehem Hollow is providing excellent service.

Drilling Stubborn Ore in Northern New Jersey

Operating nearly a half-mile beneath the surface in the Sterling Mine of The New Jersey Zinc Co., at Ogdensburg, N. J., drilling crews are continually faced with formidable opposition: medium-hard limestone, plus concentrations of willemite, zincite, and franklinite.

To dislodge the ore and mineral deposits as quickly and economically as possible, the crews are using jackhammers, stoppers and drifters, equipped mainly with Bethlehem Hollow Drill Steel, and fitted with either multi-use or carbide-insert bits. The Bethlehem Hollow, in 1 1/4-in. rounds, 7/8-in. hexagons, and 7/8-in. quarter-octagons, makes blast-hole patterns up to 15 ft deep. It's giving a good account of itself, too. Reconditioning is done at The New Jersey Zinc Co.'s modern shop at the mine site.

Bethlehem Hollow Drill Steel is ideal for all types of

difficult mine applications because it is rolled from a tough, fatigue-resisting steel. Its wide quenching range makes it easy to heat-treat for the proper balance of hardness and wear-resistance. It also makes possible long-wearing threads and tough shanks.

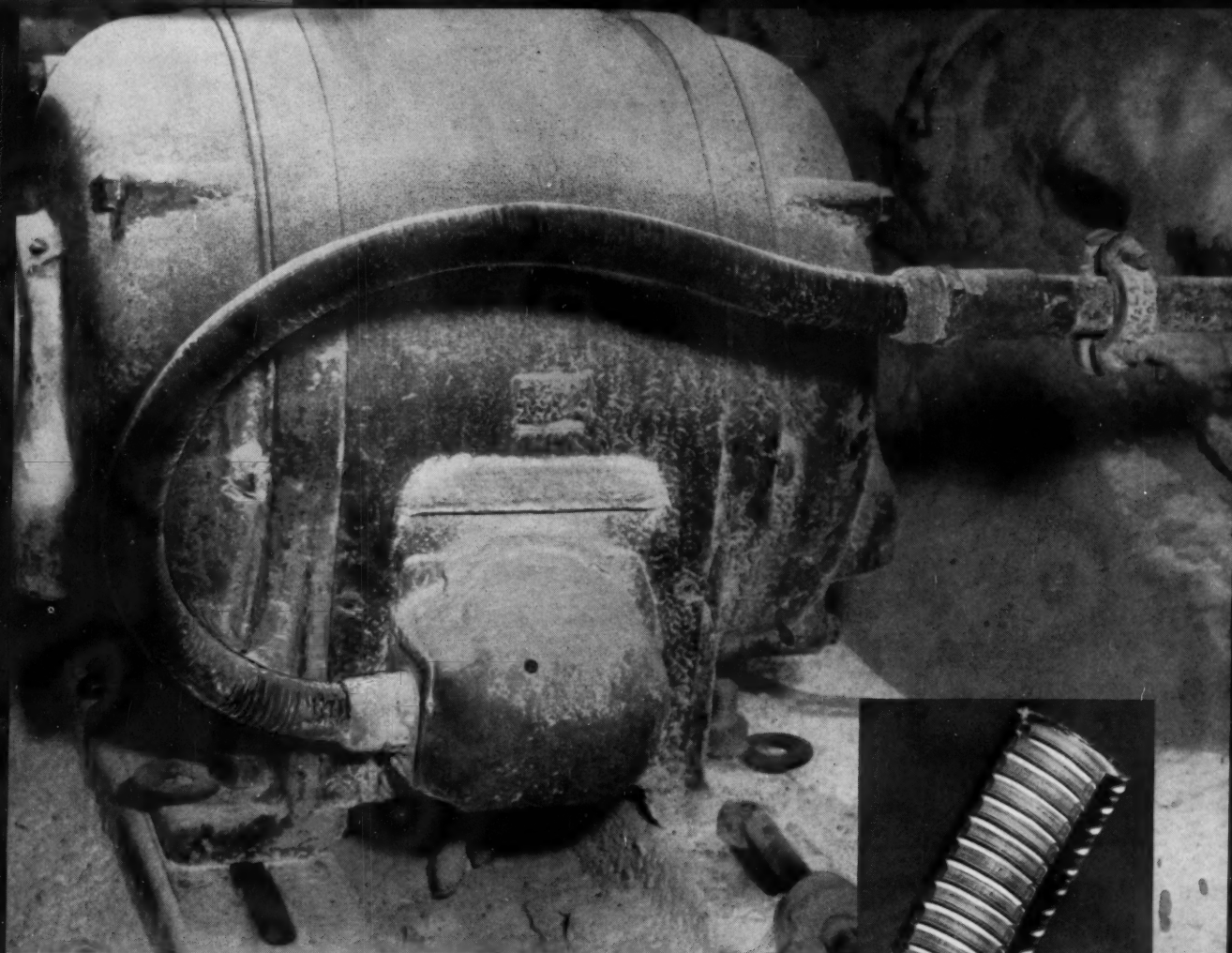
Bethlehem Hollow Drill Steel comes in rounds, hexagons and quarter octagons, and is usually supplied in lengths of from 18 to 25 ft. Longer lengths can be furnished for special requirements. For top performance, choose Bethlehem Hollow for your drilling program.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation



BETHLEHEM HOLLOW DRILL STEEL



Sealtite protects leads to motor under a blanket of penetrating, chemical "snow"—powdered calcium sulphate, magnesium oxide and magnesium chloride.

Sealtite Flexible Conduit ends circuit failures in chemical "snow" ... saves \$3 to \$5 per lead

Before Sealtite* came on the job, conduit carrying leads to electrical equipment didn't last long in this chemical "snow."

Five years ago, Westvaco Mineral Products Division of Food Machinery and Chemical Corporation began replacing leads with Sealtite flexible, liquid-tight conduit. Sealtite resists the action of the chemical "snow." Leads have stopped shorting out.

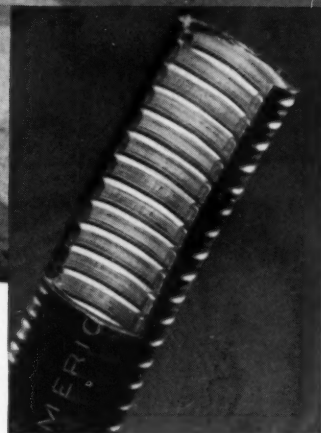
Westvaco saves money with Sealtite. They used to wrap ordinary flexible steel conduit with rubber tape, then give it two coats of a hard, protective varnish. That cost from \$3 to

\$5 per lead. Now they save this money. Sealtite has its own protective covering—a tough, extruded polyvinyl. But more important—since 1950 there haven't been any circuit failures at equipment protected by Sealtite.

What can Sealtite do for you? It resists oil . . . chemicals . . . corrosive atmospheres . . . weather. It absorbs vibration . . . protects wiring between moving parts . . . solves problems of misalignment. For complete information, write: *The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn.*

*Trade Mark

55161



Cutaway section of Type UA Sealtite shows tough polyvinyl covering over interlocked, zinc-plated steel strip. Copper conductor wound spirally in space between each convolution inside conduit provides positive ground.

SEALTITE
FLEXIBLE, LIQUID-TIGHT CONDUIT
AN
ANACONDA®
PRODUCT

Made in two types. Type UA approved by UL for service in wet spots. Type EF1—extra flexible—meets JIC standards. Available with jacket of machine tool standard light gray. Electrical wholesalers stock both types in easy-to-handle coils—you cut it on the job without waste.

†Pat. App. For





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Reduce Nozzle Changing
with Long-Life
NORBIDE® Nozzles

These rugged nozzles — lined with NORBIDE Boron Carbide, the hardest manufactured material commercially available — maintain stream contour and last hundreds of hours longer than any other Nozzle made, eliminating expensive nozzle changing.

Available in a variety of sizes and styles. Try 'em on your toughest blasting jobs. For full details, write for your free copy of Form 543.

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41 New Bond Street, Worcester 6, Mass.

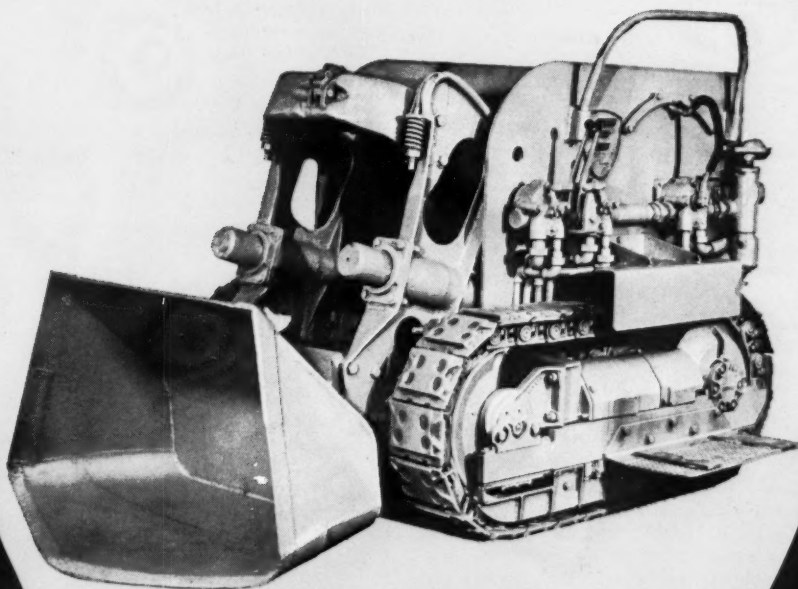


NORBIDE®... *The Longest Nozzle Life You Can Buy*



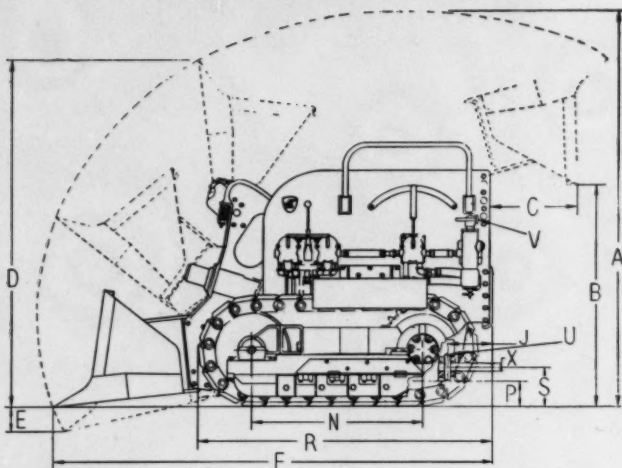
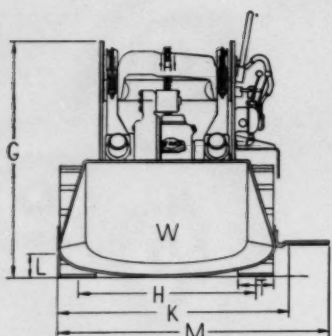
answer to

"trackless" mining



**MODEL
630**

EIMCO MODEL 630 SPECIFICATIONS



	FEET	MM
A. Head Room Std. Bucket.....	7'10" - 9'5½"	2390-2885
Head Room Nested Bucket.....	6'8" - 8'8"	2030-2640
B. Discharge Height Std. Bucket.....	4'4" - 6'2"	1320-1880
Discharge Height Nested Bucket.....	3'8" - 5'10"	1120-1780
C. Discharge Distance Std. Bucket.....	19" - 22"	480-560
Discharge Distance Nested Bucket.....	12"	305
D. Height at Minimum Length (Std. Bucket).....	7'3"	2210
E. Digging Depth Below Grade.....	8½"	215
F. Overall Length (Bucket Down - Std. Bucket).....	9'4"	2845
G. Minimum Height.....	4'11½"	1510
H. Track Gauge.....	45"	1145
J. Distance from Drawbar to Rear of Machine.....	11½"	285
K. Minimum Overall Width.....	4'10½"	1490
L. Oscillation at Center Line of Front Idler.....	6"	150
M. Overall Operating Width.....	5'8½"	1745

	FEET	MM
N. Length of Track on Ground.....	43¾"	1115
P. Ground Clearance.....	6"	150
R. Minimum Length.....	6'3½"	1910
S. Height of Drawbar Above Ground.....	9¾"	245
T. Track Shoe Width.....	9"	230
U. Drawbar Pin.....	1½" dia.	38
V. Air Inlet - Pipe Size.....	1½" IPS	
W. Bucket Capacity.....	5½-11 cu. ft.	¼-½ cu. M.
X. Drawbar Tongue Opening.....	2"	50
Weight Complete.....	9400 lbs.	4260 Kg.
Area of Ground Contact.....	790 sq. in.	5,100 sq. cm.
Speed.....	0-1.5 m.p.h.	0-2.4 Km/hr.
Y. Motors (Eimco Air or Electric).....	3	3
Electric Motor Rating.....	Special	
Air Motor Rating.....	12 HP @ 90 p.s.i.	
Drawbar Pull (lbs.) at Zero Track Slippage.....	10,600 lbs.	4,800 Kg.

Eimco's 630 series, air or electric powered crawler loader is the answer to a need expressed by miner and contractor alike.

The 630 has many advantages in design for the loader user. Independent track control provides a pivoted turn by running one track forward and the other reverse. This feature makes it possible to attack the muck pile from any angle without backing to make a new run. Improved rocker-arm design provides better action and longer life. All wearing parts are easily replaceable in new patented design. All parts easily accessible. Tracks oscillate for uneven ground. Tracks are equipped with spring release to clear rocks or obstructions in the tracks. Heavy shafts and oversized anti-friction bearings are used throughout. All parts are of heavy alloy-steel cast or fabricated construction for typical Eimco long-life heavy duty operation. Loading capacity 2-3 tons per minute.

Write for complete information.



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ON THE COVER

THE mountain highway between Ouray and Silverton, Colo. (page 206), is now kept open the year round, but this wasn't always so. The combination of heavy snowfall and steep slopes is an excellent creator of snowslides, and the former narrow toll road was little protected from them. Consequently, it was not unusual for the route to be closed for considerable periods in winter by avalanches. Sometimes the accumulation was too deep for the unmechanized road crews to handle and, in any event, removal might have promoted further sliding by unblocking the snow upslope. A simple and effective solution was tunneling. Our cover picture shows a stagecoach at the portal of such a bore. It was taken in the spring of 1903. Note the trees embedded in the snow in the background.

IN THIS ISSUE

NATURE obligingly charges most underground petroleum reservoirs with gas that pushes the oil to the surface when the host formation is tapped by a drill. After the gas pressure has been exhausted, pumping is resorted to. Together, these two methods of "primary" production normally account for approximately half of the oil originally in the deposit. To get more, some form of "secondary" recovery must be adopted. One course of action is to inject water under pressure so that it will push the trapped oil to the bottoms of pumping wells. The biggest water-flooding project yet attempted is now functioning in Osage County, Oklahoma. Our leading article gives the particulars.

TURNING on a water spigot is second nature and we seldom give a thought to the valve that reacts so reliably to our touch. Valves are equally important in homes and industries. Without them, piping systems would function poorly and compressors and pumps would lose much of their usefulness. Beginning on page 203 we take note of the centennial of Crane Co., largest of the many valve makers.

COLORADO and Hawaii, two popular vacationing places that differ widely in terrain and climate, get attention in this issue. Colorado's Million Dollar Highway (page 206) is one of the state's most scenic travelways, yet is so far off the beaten track that comparatively few tourists ever get on it. . . . Hawaii's famed Waikiki Beach is growing fast. A 2-page picture spread (page 200) shows how a new building is being given a firm footing on piles driven into the sand with air power.

Compressed Air Magazine

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A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

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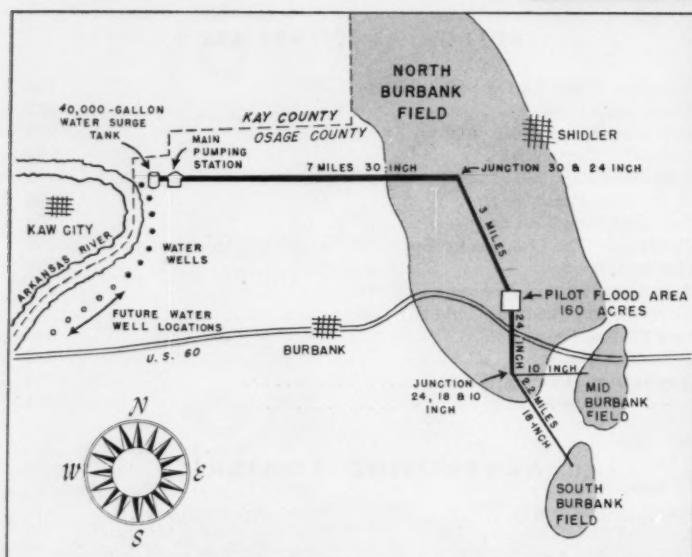
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Industrial Arts Index and in Engineering Index.

SWAPPING WATER FOR OIL

North Burbank water-flooding scheme in Oklahoma is the world's largest

C. H. VIVIAN



LAYOUT OF PROJECT

During the next twenty years or so, millions of barrels of water will be taken from the ground at the left, pumped several miles and injected underground to force sluggish crude oil ahead of it to the bottoms of wells through which it will be pumped to the surface. The scheme, largest of its kind ever undertaken, is expected to yield 140 million additional barrels of oil from the North Burbank Field and lesser quantities from several smaller areas.

TRADING water for petroleum is becoming big business, but it involves more than simple bartering. The exchange we are writing about takes place hundreds, often thousands, of feet underground in oil-bearing formations. Fundamentally it consists in forcing water down certain wells to drive the oil before it through the porous rock to other wells, where it is pumped to the surface. The oil industry calls the technique water flooding, and it is a leading and growing method of "secondary" pe-

troleum recovery in the United States.

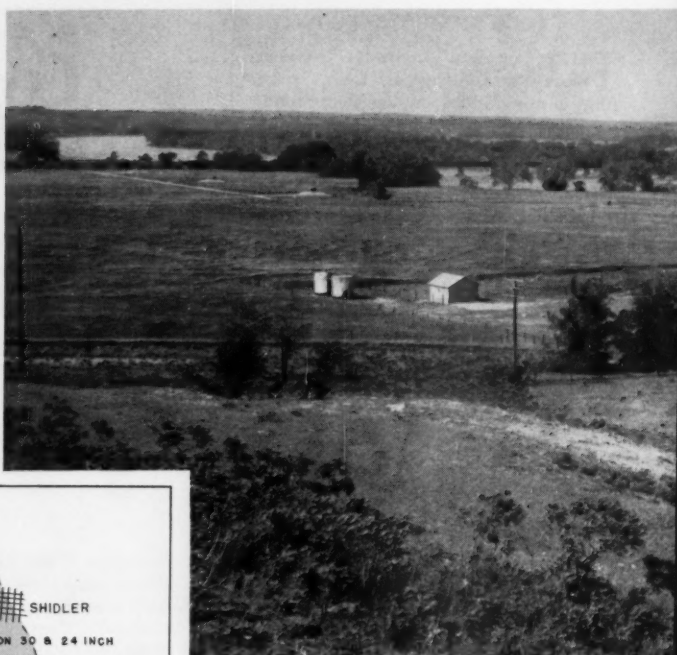
Nature locked most of our petroleum deposits in tightly sealed rock structures under great pressure from contained and accompanying gas. When a drill taps such a reservoir, the oil spurts or gushes to the surface, like an effervescing bottle of freshly opened carbonated beverage. This spontaneous flow continues as long as the gas pressure holds up, and nowadays every effort is made to "keep the cork in," so to speak. In the old days this was not so, and the precious gas was permitted to escape or was burned and the wells soon stopped flowing.

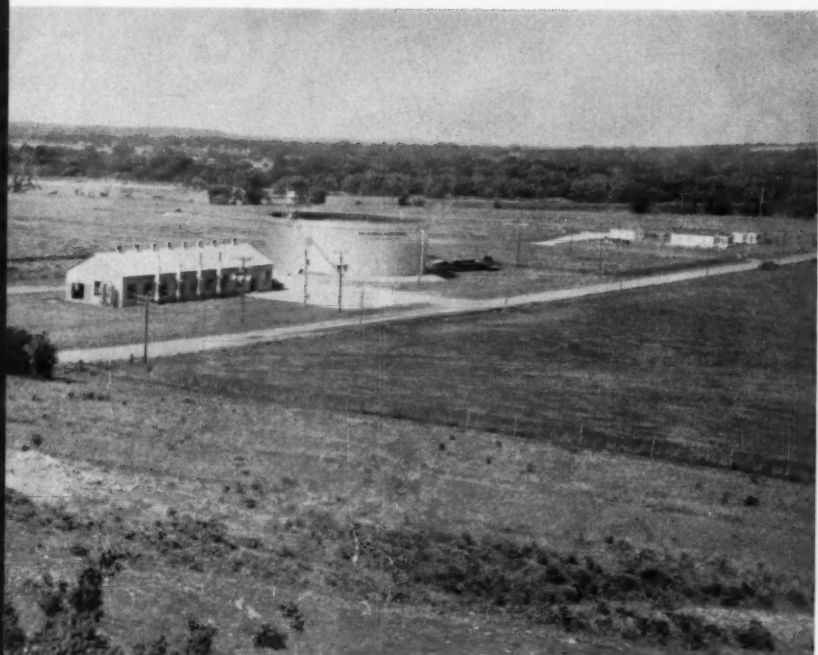
Even the conservation measures now generally practiced only postpone the time when energy in some form has to be expended to wrest more oil from the earth's grasp. Mechanical pumping is then usually started, and it has been responsible for most of our oil production to date. But pumping, too, is subject to the law of diminishing returns, and when

it is no longer profitable oil men turn to some form of secondary recovery—generally repressuring with air or gas, or water flooding.

The biggest water-flooding venture undertaken to date is well underway in northern Oklahoma. Called the North Burbank Water Flood Project, it will require fifteen more years to reach full development. It is expected to add 140 million barrels to the output of the North Burbank Field, a large quantity compared with the 170 million barrels so far obtained. Even then, only about half of the original deposit will have been recovered, it is estimated. Still in the ground will be in excess of 300 million barrels—a challenge to the ingenuity of future petroleum technologists.

The locale of the operations is the land of the fabulous Osage Indians, who were figuratively showered with wealth when their none-too-rich cattle ranges suddenly began to spout oil. The Osages for-





ARK-BURBANK WATER STATION

Wells that yield water which seeps from the Arkansas River (extreme left in picture above) into a porous underground layer of gravel are spaced 350 feet apart on the near side of the stream. The pumping station and surge tank are in the right-center (also shown at close range at the left) and the operators' homes are at the far right.

merly lived in Kansas, but sold their holdings there in 1872 and migrated to Indian Territory, now Oklahoma, where they bought 1½ million acres from the Cherokees for 70 cents an acre. This tract is now Osage County, the largest in the state. Until oil was discovered the settlers eked out a living from this prairie land.

The governing body of the Osages is the tribal council, presided over by the chief, a full-blooded tribesman, who opens the meetings in the Osage tongue. The council decided early to divide the land among the members, and each participant received 600 acres. However, the mineral rights were vested in the tribe as a whole. They include not only gas and oil but also all other mineral products down to sand and gravel used in roadbuilding.

Around 1910 a plan was drawn up for dividing the income from the mineral rights. It works about like a stock com-

pany, but each of the 2229 shares allotted at that time is called a headright. A few have been sold, but the canny Osages have held on to more than 90 percent of them, even though the owners have scattered widely and some of them now live in California. The rights are passed down to children in the same manner as other kinds of property. Income from them is collected by the tribal council which pays all tribal expenses, including salaries and other costs of maintaining the Department of Interior agency at Pawhuska that watches over the Osages' interests, and then divides the balance among the headright holders.

The Osages granted their first oil lease to Edwin B. and H.V. Foster, brothers, of Westerly, R.I., who were building a railroad line from Kansas City, Mo., to Coffeyville, Kans. The lease was executed on March 16, 1896, by James Bigheart, principal chief of the Osages, and approved by Hoke Smith, Secretary of the Interior under President Grover Cleveland. It gave the brothers the exclusive rights for a period of ten years to all the oil and gas they might produce from any land in the Osage nation. In return, they were to pay as royalty one-tenth of all the oil withdrawn and \$50 per year for each gas well brought in.

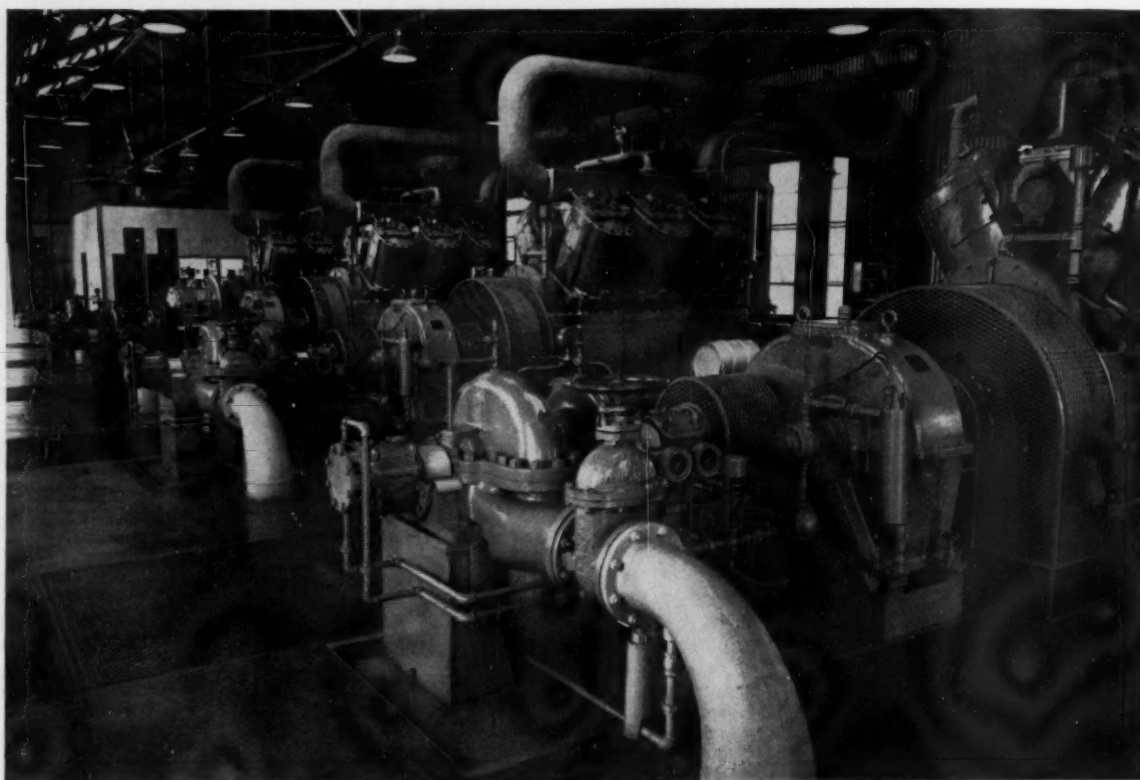
The Fosters sought the lease because they had learned that oil seeps had been reported in Indian Territory since around 1800. Edwin Foster died within a year or two, and his interest passed to H.V., who then organized the Phoenix Oil Company and Osage Oil Company. In January of 1902 the Indian Territory Illuminating Oil Company was formed and Foster subleased his holdings to it on a one-eighth royalty basis. He was thus insured an "overriding" royalty of 2½ percent, the difference between the one-eighth he received and the one-tenth he was bound to pay the Osages.

The first two wells drilled were unproductive, but the third yielded a small quantity of oil from the Bartlesville sand. Delay in the arrival of equipment from Coffeyville kept this well from being the first one in Indian Territory to strike oil, a distinction that went to the Nellie Johnstone No. 1, near Bartlesville, on April 15, 1897.

When the Foster lease expired in 1906 it was renewed for another 10-year period but limited to the eastern half of Osage County. When this second lease ran out in 1916 the tribal council adopted a policy, which still prevails, of leasing by quarter-sections only. As Foster had been subleasing some tracts for as much as one-sixth royalty interest, the Osages also began to specify that rate of payment and received as high as one-fifth under certain conditions. However, when plans for the current water-flooding program were being formulated, they agreed to reduce their share of the returns from it to one-eighth, which is the customary payment to landowners nowadays. Their cooperation helped materially to make the flooding scheme practicable. Actually, the cost of equipping the field for this method of secondary recovery will about equal the amount that was expended for its primary development.

Leases on the Osage holdings were then and still are auctioned off at Pawhuska every three months. In the early days of the North Burbank Field they were sold in tiers of land, 160 acres at a time. One lane became known as the "million-dollar-road" because the lease on every quarter-section flanking it brought at least a million dollars. A predecessor of Cities Service Company set the record with a bid of \$1,990,000 for one unit—almost \$12,500 per acre. Colonel Waters, the auctioneer, cried because he was unable to attain his ambition of at least once reaching the \$2-million mark.

All drilling was then done with steam-powered cable-tool rigs. Wells were spaced one to each ten acres, or sixteen on every quarter-section. Companies obtaining leases on adjoining tracts raced to see who could punch a hole down to pay sand first. Some of them had their rig timbers and drilling machinery loaded when the sales were held, ready to start



WATER-STATION PUMPS

View of the four Ingersoll-Rand units that pump the water withdrawn from the ground to the fields where it is injected. Each unit consists of a 6-cylinder, V-type engine operated by natural gas at 475 rpm and driving a 2-stage

Type GT centrifugal pump at 1900 rpm through Lufkin speed-increasing gears. Each engine develops 382 hp at the 1500-foot altitude. The pumps will each handle 2085 gpm of water against 498 feet of head.

operations as soon as the lease was bid in.

The North Burbank Field, most important of the many in Osage County, was discovered in May 1920. The first well, drilled by the Marland Oil Company, now the Continental, was a gas producer. In the following September, Carter Oil Company, a subsidiary of the Standard Oil Company of New Jersey, brought in an oil well, and the excitement started. Burbank soon boiled with activity.

In that post-World War I era, petroleum brought a good price. Burbank crude was especially desirable because the heavy ends that remained after the more volatile products had been taken off in the straight-run stills made an excellent bright stock for a high-quality lubricating oil. Output climbed to a peak of 122,000 barrels daily in July 1923, and the field became the biggest earner for the Osages, whose income that year exceeded \$30 million, or \$12,500 per headright. Ten years later North Burbank's production had dwindled, and the Osage take failed to reach \$3,000,000 in any year in the 1930's. In 1949, when the flooding project was started, headrights received \$1565 each and output was down to 3910 barrels per day. As a

result of the secondary recovery it has reached 8500 barrels and is still rising. Meanwhile, Osage income was up to \$3355 in 1954.

Although the fortunes of the Osages have experienced mercurial ups and downs, the over-all monetary statistics are impressive. Up to January 1, 1950, the returns from their oil and gas holdings came to more than \$290 million. The sale of leases accounted for \$115,783,000 and rentals for \$2,542,000. Oil royalty payments totaled \$152,153,000 and gas royalties \$21,321,000. The share of each headright in the aggregate was \$133,000. This explains why the Encyclopedia Britannica states that the Osages are "the richest people (per capita) in the world."

North Burbank had a woefully short period of "flush" production; the law of supply and demand was the only halter on output. The importance of preserving the energizing gas that pushed the oil to the surface was either little understood or ignored. Wells were permitted to flow "wide open," and the only concern was to get as much of the magic fluid as possible before your neighbor took it out from under your land. The wells flowed naturally for a while and

then had to have help of some kind.

As early as 1924 the practice of "pulling a vacuum" on the wells was begun and was continued until 1939. Gas injection to restore or maintain pressure was started in 1926 and became important by 1935. The South Burbank Field was opened in 1934 and for a time supplied gas to North Burbank. After that a 12-inch line was laid to pipe gas in from other districts. Gas injection has continued to the present and is being resorted to in areas that have not yet come under the water-flooding program. Up to 1950 it accounted for 15,000,000 barrels of North Burbank's total yield of 170 million barrels.

The North Burbank Field measures approximately $4\frac{1}{2} \times 12$ miles and contains 23,240 productive acres. The oil-bearing horizon—the Burbank sandstone—is about 2900 feet beneath the surface. It was laid down during the Pennsylvania geological period along the western shore of what geologists call the Cherokee Sea and is a lens made up of innumerable overlapping narrow sand bars presumably created by shore-line currents and waves. It differs in thickness from an inch to 100 feet, but averages about 47 feet.

The sandstone is composed of fine and medium-size quartz grains cemented with silica, dolomite and calcite. Fragments of chert, shales and schist make up 10-20 percent of it, with around 5 percent of silt and clay and small amounts of mica and carbonaceous matter. The porosity varies and is too low in some places to permit the recovery of much of the contained oil by secondary methods. It is estimated that the North Burbank Field formation originally held some 670 million barrels of oil, or an average of 36,000 barrels per acre.

Approximately 18,000 of the 23,240 productive acres in the field are in the flooding project. The remaining 5240 acres—in the northwest section—lie in Kay County and were excluded from the scheme largely because ownership of leases and royalties there is so widespread that it would be a tremendous job to get the consent of everybody concerned.

The general plan is to put 1000 acres under flood each year, which means that complete development will take around eighteen years from the starting time, which will carry the work up to 1969. It is expected that output will reach a peak of nearly 20,000 barrels per day by 1964 and continue for perhaps thirteen years, or to 1977, on a gradually lessening scale. Now, in the fifth year of operation, water has been applied to 4000 acres and the daily oil production attributable to flooding has risen to 6700 barrels.

To put the project on the same economic footing as other water-flood undertakings, the operators of the North Burbank Field petitioned the Osages for a reduction in the royalty rate, as was previously mentioned. The owners were also asked to sign a blanket oil-mining lease covering their entire acreage to replace the existing individual leases on the different tracts. Their agreement to these two requests paved the way for uniting the interests of all eighteen operators in the field. Then the North Burbank Water Flood Unit was organized, with the various operators receiving interests based on their accumulated and current output in addition to their current productive acreage. As the holder of the largest share (51 percent), Phillips Petroleum Company was designated the operator.

The unit formally came into existence on November 14, 1949, when the Department of the Interior approved the agreement with the Osages. A "pilot" operation covering 160 acres was set up in February 1950 by drilling nine water input wells within a group of sixteen existing wells. It began to function on February 25, and by the following September, after 1,200,000 barrels of water had been injected, oil output had increased from 37 to 404 barrels per day. It reached a peak of 987 barrels daily

in January 1951. Besides demonstrating the feasibility of flooding, the pilot operation made it possible to gather data and thereby compute the probable recovery that might be expected from the whole field.

During the preliminary period, salt water brought up with the oil in the entire field, together with some purchased fresh water, was used for injection. Steps were then taken to provide the much larger supply that would be needed to initiate the major project. It was determined that the requirement for North Burbank would be around 200,000 barrels daily. It was realized, also, that worth-while savings could be effected if operators of neighboring smaller fields would join the water-supply pool, and they accepted the proposal. The other areas concerned are the Mid-Burbank, South Burbank, Stanley Stringer and the Fairfax. This raised the demand to 300,000 barrels per day, and what is known as the Ark-Burbank Water System was set up to provide that quantity.

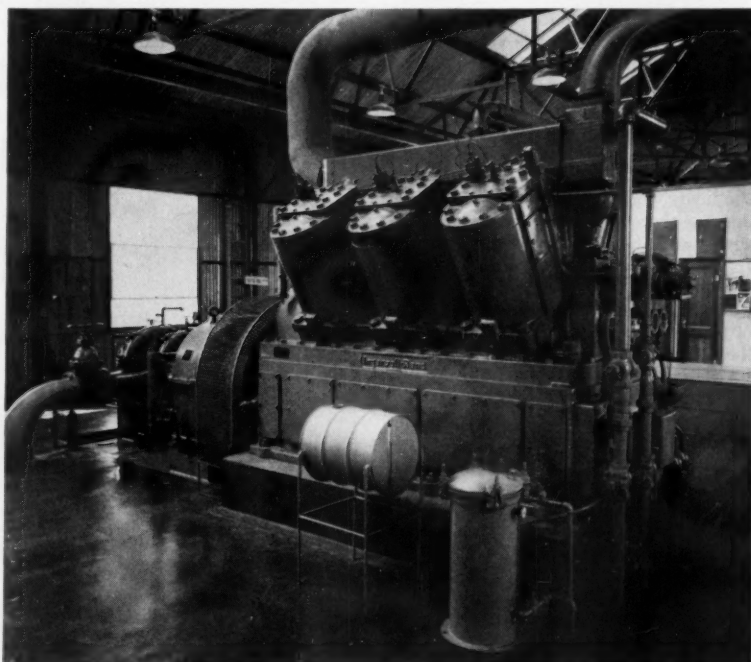
Various schemes of obtaining the necessary water were considered, including the sinking of wells to the Arbuckle lime horizon and creating reservoirs to impound surface runoff. Further study disclosed that at a point only $7\frac{1}{2}$ miles from the field water was seeping from the Arkansas River into an underground alluvium bed 50 feet thick and that it could be pumped from shallow wells on one bank. Water rights were purchased

and seven wells were put down at intervals of 350 feet. Tests showed that each was good for up to 35,000 barrels daily. Additional wells will be sunk when the demand for water exceeds their combined output of 245,000 barrels per day.

All the wells go through the alluvium to a bed of underlying rock. The deepest one is down 57 feet, and each is 40 inches in diameter. The water is brought up through a 16-inch slotted casing that is surrounded with loose gravel throughout its length. At each well there is a deep turbine pump driven by a 23-hp Ajax gas engine.

As the water percolates through the alluvium between the river and the wells, it loses all turbidity, but as some sewage is admitted upstream it contains bacteria. If left alone, their products, together with algae, would later clog the pores in the oil-bearing stratum. To prevent this the water is treated with quaternary ammonium bactericide, the designated amount being added by means of a chemical proportioning pump while the water is on its way from the wells to a cylindrical steel surge and settling tank of 45,000 barrels capacity. The tank has a floating metal roof to exclude air, which might promote corrosion and instability.

Although individual wells have supplied as much as 38,000 barrels in a day, the aim is to operate them at about 30,000 barrels each. Their output is regulated so as to maintain a prescribed



CLOSE-UP OF PUMPING UNIT

The compact engine has good running balance and requires a relatively small foundation block. The pump is a ball-bearing unit that has wide application in oil fields, mining and general industry.



OPERATOR'S ROOM

The engine-pumps run 24 hours a day, but the superintendent and his assistant are on hand only eight hours and the machines operate unattended for sixteen hours daily. Instrumentation on the gas engines and on the panel shown at the right provides 22 controls that will either close down the units or actuate visible and audible alarms if anything goes wrong. The alarms are "piped" into the superintendent's nearby home when he is not on duty. The sign overhead lists the 27 co-owners of the water system.

level in the surge tank, which merely "floats" on the line. If four wells are functioning, the pumps serving three of them are run at constant speed, and the speed of the fourth unit is varied in accordance with the tank level. This is done by means of Taylor pressure-controller recorders, which control the carburetor butterfly valves on the gas engines that drive the pumps.

From the tank the water is pumped to the fields where it is injected. For this purpose there is a central pumping plant that runs 24 hours a day. It contains four Ingersoll-Rand 2-stage, 6-inch centrifugal pumps each rated at 2085 gpm (about 3,000,000 gpm daily) against 498 feet of head (215 psi pressure) and operated by an Ingersoll-Rand Type PSVG 382-hp, 6-cylinder gas engine. Each engine runs at 475 rpm and the pump at 1900 rpm, the increase being accounted for by a Lufkin gearbox interposed between the two units. The gas engines are started by introducing air at 250 psi pressure supplied by an Ingersoll-Rand 2-stage belt-driven compressor. The latter is equipped for operation by either an electric motor or a gasoline engine.

As each pumping unit can handle 70,000 barrels daily without pushing it, and the plant is now delivering 100,000 barrels a day, the four machines are more than sufficient for the time being, but all are run in turn to equalize wear and to make sure that they are kept in first-class condition. As the flooded acreage

increases in years to come, the load will mount steadily. It is expected that a fifth pump will be added in about ten years, and with that in mind a foundation for it was provided when the station was built. Even then four units will probably be capable of meeting the

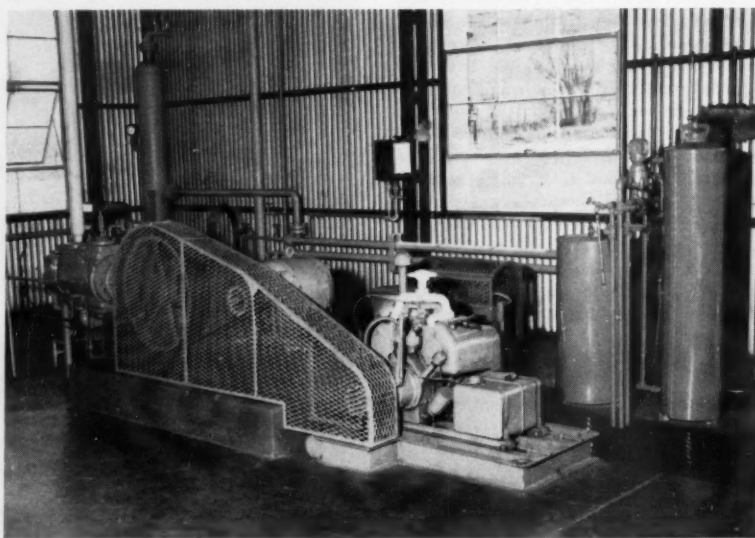
demand and the fifth will serve as a standby.

The plant is so complete as to instrumentation that little supervision is required. If the surge-tank water is drawn down too low all pumping engines in use will shut down automatically. Similarly, individual engines are safeguarded against low fuel pressure, high or low lubricating-oil pressure, high cooling-water temperature and other abnormal operating conditions.

All told, each engine-pump unit has 22 controls. Eleven of these will stop the unit if the conditions over which they stand guard deviate from normal and the remainder will sound alarms and turn on red lights. Wherever oil-field installations exceed 100 hp, it is customary to divide around-the-clock service into tours or shifts, but because of the aforementioned safeguards that is not considered necessary and the plant is run on a 24-hour schedule by the superintendent and one operator. The alarms are "piped" into the nearby home of the superintendent during periods when no one is on duty in the station.

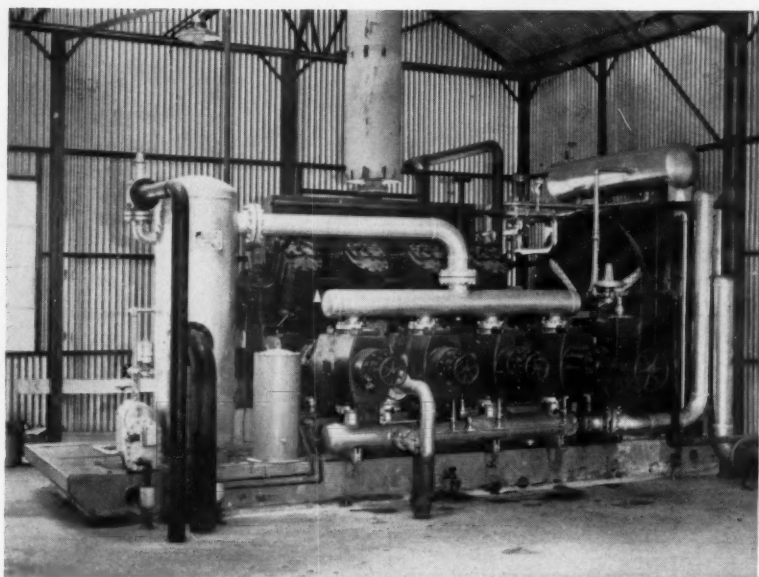
Water is delivered from the station to the injection areas by a 30-inch line extending 7 miles eastward to the north-central part of the North Burbank Field. From there a 24-inch main goes southward for 3 miles to a junction, whence an 18-inch line continues 3 miles southward to the South Burbank Field and a 10-inch line runs 3 miles eastward to the Mid-Burbank Field. So far 720 acres in Mid-Burbank and 700 acres in South Burbank have been brought under flood.

The North Burbank Field was originally laid out on a 10-acrespacing pattern;



STARTER FOR GAS ENGINES

Compressed air at 200 psi pressure for starting the gas engines that drive the pumps is supplied by this Ingersoll-Rand 2-stage compressor. It is arranged to be driven by either electric motor or gasoline engine.



that is, an oil well was located in the center of each 10-acre tract. The pilot operation was developed by drilling nine water input wells to serve sixteen oil wells (one water well in the center of each group of four oil wells). In extending the pilot-flood area, alternate oil wells were converted for water input, leaving those remaining to serve as producers. Thus each producing well is surrounded by four injection wells on 20-acre spacing.

In putting the old wells in condition for injection service it was necessary to make certain that all porous formations above the oil-bearing sand were sealed off with casing and concrete to prevent the escape of water into them. Where existing wells could not be satisfactorily converted, or where the wells had been plugged, new wells had to be drilled. A different pattern was used in making the 1954 extension. All wells in alternate east-west rows were plugged and new wells were sunk midway between them. This arrangement is now being tested.

In the field, the water is boosted in pressure to 650 psi for injection. There are now six pumping plants at North Burbank for this purpose and others will be added as the program is expanded. Each is located in the middle of a 640-acre tract and serves all the wells in that area through piping extending in all directions and incorporating manifolds from which there are take-offs to groups of wells. Individual pipes to each well are 2½ inches in diameter. Every station contains from 2 to 6 pumps, each of 150-gpm capacity and powered by a 70-hp gas engine, and the pressure drop from a station to the corner wells of a section is usually about 32 psi. Around 2000 barrels of water per day is injected into each well at the outset, but this



GAS-STORAGE PROJECT

As all the pumps of the water-flooding system are driven by gas engines, an uninterrupted supply of natural gas is a vital necessity. During extremely cold weather, however, the utility from which it is purchased may have to deliver it elsewhere for comfort heating. To meet such an emergency if it should arise, gas is stored during warm weather in a small depleted field a few miles away. Two Beaird-Ingersoll-Rand gas engine-powered compressors located in a small building (right) over the field compress it for injection into the ground and again upon its withdrawal to transmit it to points of use. The semiportable machines are mounted, complete with cooling system and all other auxiliaries, on base plates and normally operate with only occasional attendance. The unit shown is a 330-hp IVG. The second one is of the same type but of 220 hp.

quantity is gradually reduced and levels off to around 500 barrels after conditions become stabilized.

Oil is pumped from each producing well by an individual beam-type pump driven by a 35-hp gas engine. These are all new units and replace small "jacks" previously operated part time in groups by means of rod lines extending from centrally located power sources. Considerable water is recovered along with the oil, some of it connate or sea water

that was trapped in the formation when it was laid down and the remainder fluid that was injected for flooding. All of it is separated from the oil and pumped back into the ground. Field gathering lines feed the oil to a transmission line for delivery to refineries in Kansas City, Mo., Coffeyville, Kans., and Tulsa, Okla.

As all the pumps involved in the operations are driven by gas engines, an adequate and continuous supply of gas is of vital importance. This fuel is purchased from a utility, which may, during unusually severe or prolonged cold spells, be obliged to divert some or all of the allotment to other customers for space-heating purposes. The contract consequently stipulates that service may be cut off in the wintertime. To be prepared for such an emergency, Phillips has converted a

The word "Osage" is Wa-Sha-She in Indian language. It means "white hair" and was the name of a respected and famous chief of the tribe.



EARLY GAS-COMPRESSION PLANT

In the 1920's the Phillips Petroleum Company, expanding in size by virtue of its holdings in the Burbank Field, established numerous plants for extracting "natural" gasoline from the gas produced with the oil. Some of them are still operating and will probably continue to do so for some years now that water flooding is extending Burbank production. This picture shows a line of twenty

Ingersoll-Rand compressors and vacuum pumps in the first Burbank Field plant which was built in 1922 and is still in service. The black streaks across the floor are the bottom sections of long belts extending across the room to gas-engine drivers, which total 3300 hp. This arrangement contrasts sharply with modern direct-connected engine units.

small depleted gas field about 6 miles east of the North Burbank Field into a storage reservoir. The utility's delivery line passes right over it and supplies gas for storage during the warm-weather months when the demand for space heating is relatively low.

Two compact "packaged" compressors, one of 220 hp and the other of 330 hp, complete with all auxiliaries on metal base plates handle the gas at the field. They are Ingersoll-Rand gas engine-driven units that have been mounted and specially equipped—made mobile—for field service by J. B. Beaird Company, of Shreveport, La. These machines boost the pressure of the incoming gas for injection into the ground and later, when it is withdrawn from the reservoir, again increase its pressure before it is put into the line for delivery to the points of use.

Phillips Petroleum Company's interest in the water-flooding project has both sentimental and practical aspects because its participation in the development of the North Burbank Field started it on its way to becoming one of the titans of the petroleum industry. The concern began as a partnership of three brothers, Waite, L.E., and Frank Phillips. It was incorporated in 1917 and was a small oil and gas producer until it acquired substantial holdings at Burbank during the boom period. At that time Frank gained the friendship and respect of the Osages, who made him a member of the tribe and even permitted him to buy a headright.

The company obtained a refinery in 1927 and initiated a program of integration and growth that is still in progress. Last year it became the thirtieth corporation in the United States with assets

exceeding one billion dollars. Its overall income in 1954 exceeded \$795 million. It owns a full or part interest in more than a million acres of developed oil and gas lands and in ten million un-

GENERAL FACTS ON WATER FLOODING

CONSERVATION came late to the oil industry. Wells were allowed to flow unbridled, and the precious gas that pushed the oil from the ground gratuitously was, in most cases, burned in giant flares solely to prevent it from polluting the atmosphere. All too quickly the gushers ceased to gush and the once dynamic wells lost their "zip," just as an uncorked bottle of soda pop soon goes flat. With their natural driving force dissipated, the wells went "on the pump." When pumping no longer paid, many fields were abandoned. Now, however, secondary recovery methods are bringing a lot of them back to life. Hence the great interest currently manifest in water flooding.

Artificial water flooding of oil-bearing formations was illegal for many years and for that reason there is little information on the early operations, a few of which were undoubtedly conducted clandestinely. New York was the first state to permit flooding and Pennsylvania the second. Increased production resulting from flooding was first noted in Pennsylvania in 1907 and in New York in 1912. Output of the Bradford Field,

which is partly in the two states, is reported to have been stepped up by about 800 percent by the method.

Flooding became important in both states during the 1920's and 1930's and was responsible for rejuvenating several old fields, causing them to yield almost as much oil as they had during flush production in the 1880's and 1890's. In a few districts where stratigraphic conditions are favorable, accidental water flooding has been observed. It has occurred, for instance, since 1924 in certain Illinois fields, where some river water enters sloping oil-bearing beds and drives the petroleum ahead of it to lower levels, from which it is brought to the surface in the usual way.

Flooding is not the only successful method of secondary recovery. Repressuring the oil-bearing reservoir rock with air or gas is an even older scheme, and the use of air for this purpose apparently began at Marietta, Ohio, in 1913. Molyneux's patent for cleaning wells with compressed air or steam dates back to 1864. The application of vacuum at the head of a depleted well to draw oil into the bottom for subsequent pumping was



PHOTO, PHILLIPS PETROLEUM COMPANY

NORTH BURBANK FIELD IN 1922

A view looking eastward from the now effaced community of Whizbang during the days of the field's early development. Note the orderly lines of wells, which were laid out on a pattern of one in the center of each 10-acre

tract. This avoidance of close spacing is in accord with today's ideas of conservation and was unusual for that period. The derricks were of wood, and drilling was done with cable tools powered by steam engines.

developed acres. It is the foremost producer of natural gas, and probably has the largest gas reserves; is a leading producer of LPG (liquid-petroleum gases), of natural gasoline and of carbon black made from oil; operates seven refineries with an aggregate capacity for process-

ing more than a quarter-million barrels of crude oil daily; and was one of the first petroleum companies to enter the petrochemical industry. It has quadrupled in size in the past ten years and almost doubled in the past five. Although its producing and refining facili-

ties are centered in the mid-continent area, it markets its products in most parts of the country. Its most important trade name is Phillips 66. Its headquarters are in Bartlesville, Okla., just over the eastern boundary line of Osage County.

first tried in Triumph Falls, Pa., in 1869. Both air and gas also serve to lighten the column of oil in a well and thus "lift" it to the surface. Any or all of these procedures may be utilized to increase or maintain a field's output. In the past, flooding was seldom adopted until one or more of the other methods would no longer do the job, but today it is sometimes applied before a field has declined appreciably. Secondary recovery of some kind is now being carried on in 35 states. Texas has 700 projects in operation; Illinois 150.

Petroleum engineers estimate that flush or flowing production and pumping combined normally account for the recovery of approximately one quarter of the oil in a field and secondary methods for another quarter, leaving one half of the original content in the ground. Paul Torrey, chairman of the Secondary Recovery Committee of the Interstate Oil Compact Commission, has declared that at least seven billion barrels of oil can be obtained by secondary-recovery methods from fields that were once considered exhausted. Ernest O. Thompson, chairman of the Texas Railroad Commission (arbiter of the oil industry in

that state) believes there is a total of around 100 billion barrels of petroleum in the nation's so-called depleted pools. If he is correct, and even if but one-fourth of this dormant supply is obtainable, it would swell our present proved petroleum reserve of 33 billion barrels by 75 percent.

Water flooding is especially favored today because it involves less gamble than searching for new fields. It is reasonably certain, for instance, that North Burbank will give up 140 million more barrels under the flooding program now in progress, whereas the American Petroleum Institute estimates that the chance of discovering a new field with even a potential of 100 million barrels is one in 991 tries. Flooding is attractive to small operators in particular because they usually haven't the funds required to conduct extensive exploration campaigns.

Water flooding will not pay out unless it results in a sizable production of oil. Because some failures have been recorded, it is customary, where there is any doubt regarding its effectiveness, to try out the method on a small scale before making heavy expenditures. Under fa-

vorable stratigraphic conditions the water moves in all directions in an ever-widening circle from the bottom of each injection well. But it travels slowly, sometimes as little as 2 or 3 inches a day. The pressure of the water washes the oil from the sand and forces it through the pores to the production wells.

Reagents designed to reduce the surface tension of the water and thus facilitate its passage are sometimes introduced with it. One oil company alone has investigated the effects of 200 such additives. This is done by injecting oil, water, gas, emulsions and various chemicals into miniature models that simulate underground conditions and observing them to see which combinations move the most oil the easiest. To help the researchers duplicate closely the content of actual formations, cores are taken continually from actual drilling wells and examined for porosity, permeability and oil and gas saturation.

An increase of but 1 percent in our total oil recovery would add hundreds of millions of barrels to our national petroleum reserves, and a 1 percent reduction in the cost of producing a barrel of oil would save millions of dollars annually.





PHOTOS BY GERALD F. NICHOLS

PILING and PALMS

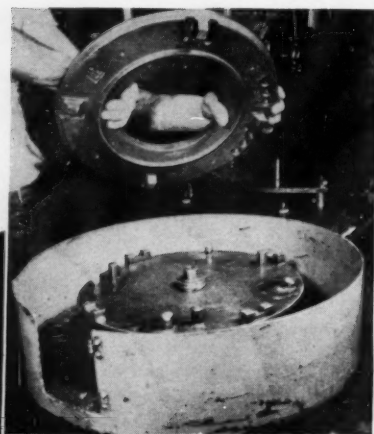
THE accompanying pictures of a site across the street from the famed Waikiki Beach in Honolulu were taken in April while an air-operated pile driver was pounding the last of 172 hollow steel tubes into the ground to provide a stable foundation for a new 5-story building. Located in the heart of the fast-growing Hawaiian tourist center, the new structure, to be owned by a group called the Waikiki Hale, will contain shops on the first floor and possibly on the second and offices above them.

The building contractor, Town Construction Company, sublet the piling work to Hawaiian Dredging Company. Both are Honolulu firms. A Northwest crane with 60-foot leads was used to sink the 48-foot piles and was supplied with air at 100 psi pressure by an Ingersoll-Rand Gyro-Flo portable compressor of 600 cfm capacity.

The full-page view from aloft shows the site, flanked by Kalakaua Avenue on the right, with the beach beyond. Clusters of driven piles form a rectangular pattern on the ground, and the rig is putting down another one. The two other pictures portray the work at close range, with one end of the compressor in the foreground.

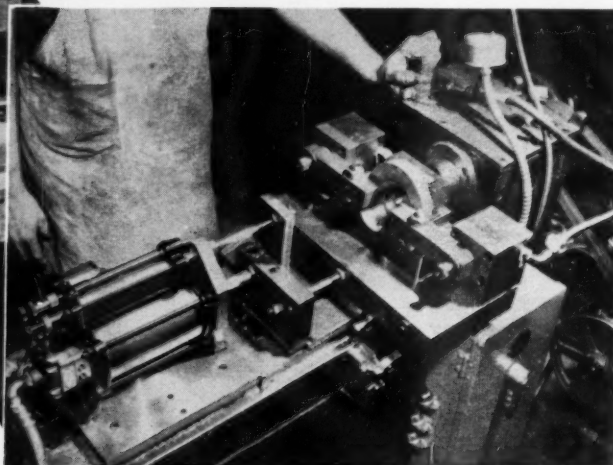


Air Power Serves Firm Well For 38 Years



AIR AIDS CLUTCH MAKING

The converted 9-inch lathe shown below bores the inside diameters of two cyclic balancer castings as they are held in position by air clamps. The pneumatic cylinder at the left forces the stock over a fixed revolving bar . . . An air cylinder located under the assembly-bench station pictured at the lower-left compresses the powerful clutch coil spring, which permits levers, steel balls, fulcrum and snap rings to be put in place . . . At the top is a "blow-out" stand where burrs and filings are removed in one operation from four freshly drilled and tapped holes. Inside the base of the stand compressed air is fed to four jets, which may be moved as required to conform to the hole patterns of different types of clutch plates. A hand-welded air hose was formerly used.



COMPRESSED air was introduced in the Syracuse, N.Y., factory of Lipe-Rollway Corporation in 1917 to alleviate fatigue suffered by machinists working long hours to produce equipment vitally needed for the World War I effort and has never relinquished its leading place. Although often coupled with electricity and hydraulic systems, compressed air is the prime source of machine-tool power. The company makes heavy-duty truck clutches, bar-feeding mechanisms and machine tools, and most of the production units in the clutch-machining and machine-tool departments have pneumatic components.

The man responsible for the use of air power at Lipe-Rollway is Laurence H. Kirk, the firm's general superintendent. He came from his plant at Havre de Grace, Md., 38 years ago to spend two weeks working with its officials on a series of patent drawings and has been there ever since. Long a believer in automatic control for machine tools, he has equipped them with pneumatic devices to lighten labor. Because the manufacture of the more than 30 different clutch sizes and models requires such a variety of setups, air-powered controls, he thinks,

are far more efficient than the more conventional overhead assembly or roller-type conveyor lines.

Pneumatic attachments, consisting of a source of air at 100 psi pressure, shut-off and check valves, meters, oiling systems, limit switches and air cylinders where needed, have replaced foot-control levers, T-wrenches and hand-chucking or hand-drilling operations. As a result, setups are simpler, the rate of making accurate machine cuts is greater and over-all production, Lipe officials say, has increased 30 percent.

Most machines have air-actuated chucks, spindles or collets, as well as air hoses for cleaning purposes. Drill presses, lathes, boring mills and assembly-bench fixtures are powered pneumatically. Even metal chips are carried out of the plant to a disposal bin by a system made up of two air cylinders and a conveyor belt. An air-controlled hook lifts each waste car into position to dump its contents onto the belt. Upon reaching the top of the conveyor, the scrap is discharged into a container, where an air-activated door opens and allows the chips to drop into the outdoor bin. To perform the entire operation the worker

is required to do nothing more than pull two chain switches.

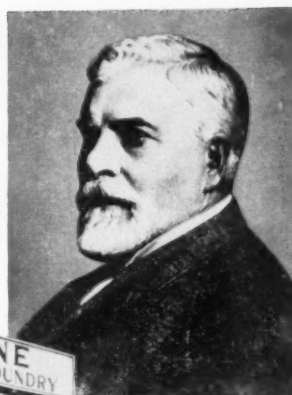
Four compressors at a central location are connected to a common manifold that serves as an aftercooler. From there the air flows into a 282-cubic-foot outside storage tank. Moisture that condenses out of the air as it cools in the receiver is removed continually through a condensate trap, thus insuring comparatively dry air at the points of use at all times.

Air lines also extend from an auxiliary compressor installed in the clutch machining department and are provided with filters and traps to lessen moisture condensation in the system. In addition, condensate traps segregate assembly department lines from those in other areas to prevent damage from moisture to air-wrench motors. Air is piped to machines at 100 psi and reduced there to the desired pressure by means of regulating valves.

All in all, Lipe-Rollway has found compressed air to be a simple, efficient and flexible power medium that should not be overlooked by machine supervisors when they are planning new production methods.

CRANE CO. CENTENNIAL

World's largest valve-making concern is monument
to the efforts of its talented founder



CRANE CO., which makes things that affect the lives of practically all of us, is 100 years old this month. Its anniversary falls on the same day as Uncle Sam's, July 4. Among the firm's 40,000 or more products, the average American most often sees bathroom and kitchen fixtures and plumbing, but the lion's share of its revenue comes from valves, pipes and fittings, which are of fundamental importance in controlling and directing the flow of water and oil, of steam, gases and compressed air. They are of concern alike to the smallest household and the biggest industry. The company and its subsidiaries own more than 300 patents relating to valves and allied equipment.

Like some other mature and well-known American firms, Crane Co. is essentially a monument to the inventiveness, craftsmanship and zeal of one man—Richard Teller Crane. He founded it and ran it for 57 of its first 100 years, and when he died in 1912 it was firmly established among the nation's leading industrial establishments. Since then it has traveled much the same course that he charted for it.

As American corporations go, Crane Co. is neither giant nor pigmy. It has fourteen factories in the United States, Canada and England, 175 branch offices and some 1000 wholesale outlets in this country and the Dominion, employs around 17,500 people in America alone, and took in slightly less than \$300 million last year. It makes a little more than half of the things it markets, and "jobs" or resells the remainder, which consists mainly of steel, wrought-iron and fiber pipe, soil pipe and fittings, water heaters, softeners and pumps, heating boilers and furnaces, radiation equipment and accessories.

In common with many of his counterparts on the early American industrial scene, Richard Crane was a dominant personality and an interesting individual. The early history of the concern is largely the story of this man who put it on its feet and gave it his name. The name, incidentally, has been changed four times, most recently from Crane Company to Crane Co.—"company" is not spelled out.

Born in Paterson, N. J., May 15, 1832,



FOUNDER AND FIRST SHOP

With his own hands, 23-year-old Richard T. Crane built a 24x14-foot frame structure in the corner of a lumberyard owned by his uncle just outside of what is now Chicago's central Loop District. The business outgrew the space in less than a year. Crane's present Chicago works, one of fourteen in the world, covers 160 acres. Mr. Crane is shown as he looked in later life.

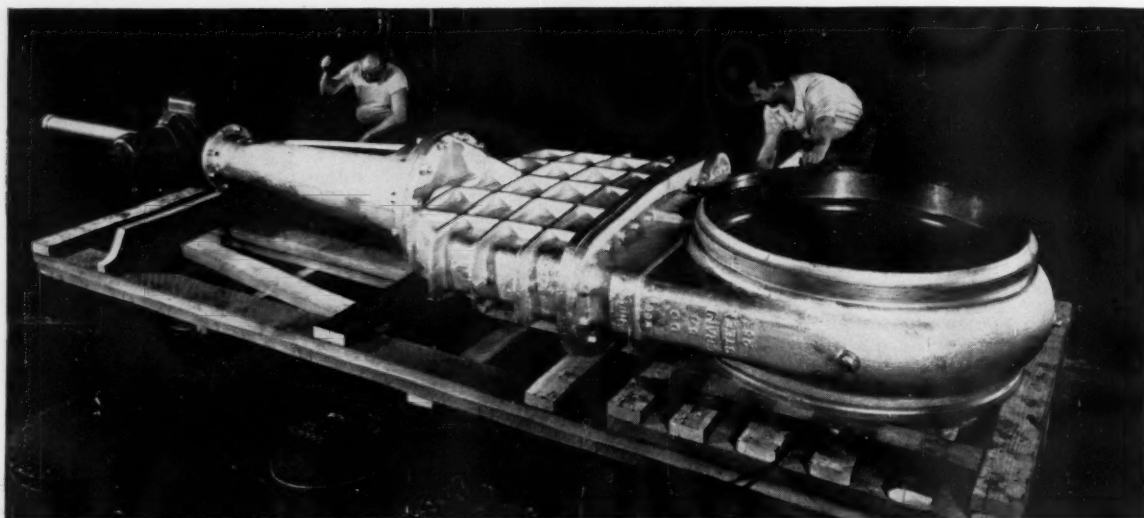
Richard Crane was orphaned early in life and went to work in a cotton mill at the age of nine. Later he did well for a time peddling tobacco, store to store, from a cart, but quit because he preferred working with his hands to selling. When fifteen, he satisfied that desire by getting a job in the brass and bell foundry of John Benson in Brooklyn. In three years, there and elsewhere, he became a competent machinist and boosted his wages from \$2.50 weekly to \$2 daily, which was 50 cents above the prevailing rate. In the spring of 1855 he moved to Chicago to be with an uncle, Martin Ryerson, with whose help he opened the one-room R. T. Crane Brass and Bell Foundry. His first products were brass couplings and copper tips for lightning rods.

A lucky break gave the new business a running start. A leading manufacturer of freight cars, steam engines and other heavy equipment, P. W. Gates & Co., couldn't get needed brass castings from its regular supplier because copper was scarce and offered Crane an order. He took it and then began to look for cop-

per. Failing to find any in Chicago, he got some in Detroit and thereafter received more business from Gates. Within a few months Richard sent for his brother Charles, a molder in the East, and also hired two other workmen. In less than a year the brothers bought a lot and put up a 3-story structure, and that was the beginning of a succession of expansions.

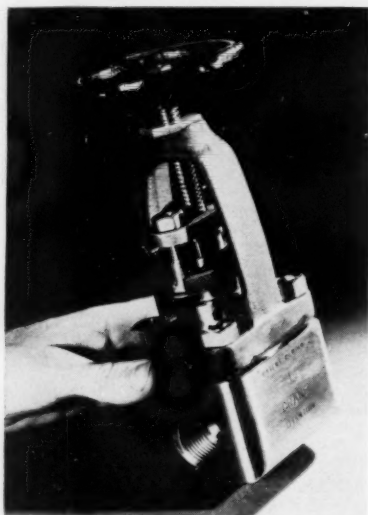
In 1865, when the concern was only ten years old and Crane was 33, he built the first malleable-iron foundry west of Pittsburgh. In 1872 his plant was the object of a study by a Prof. Charles Gardner and was written up in the *Chicago Illustrated Journal* for its outstanding character and magnitude of operations. In 1881 a pipe mill was added.

During those early years Crane's inventiveness often asserted itself. Although he did not originate mass production methods, he was probably its pioneer in the foundry field. At his direction his engineers built a merry-go-round type of casting wheel which was turned to perform different jobs at



CONTRAST IN VALVES

The first Crane valves were made in 1858, when the infant concern got what was then a big job: a \$6000 contract for installing a steam-heating system in the Cook County Court House in Chicago. Valves have been manufactured ever since, are the chief Crane product now and come in thousands of sizes and types. Shown above is a steel gate valve, part of a high-pressure air system that services three new test cells at the Wilgoose Laboratory. It is 22 feet long, weighs 14,710 pounds and has an opening 54 inches wide . . . Crane is now an important factor in the promising titanium industry and, as would be expected, used some of the first of the metal it produced in making the small valve at the left. It has outstanding resistance to corrosion and pitting in liquids that freely attack most other metals.



successive stations. Later he introduced conveyors to initiate the production line in foundry practice. Subsequently, when he manufactured steam engines for a time, he designed a machine that simultaneously bored both cylinders, the cross-head guides and crankshaft bearings. It not only speeded up the work but also assured its trueness. In his autobiography he wrote of this invention, "so far as I know, it was the first step in the specializing of machinists' tools."

Among his innovations was a 4-spindle machine with a power chuck that permitted tapping two elbows at once. The part was held in place by an air-cylinder clamp operated through a toggle joint. It replaced a much slower and more cumbersome method of clamping with screws. That was well over 50 years ago and ranks among the earliest air-power applications of this sort.

Crane was fortunate that his business

was launched in a favorable era. The steam engine was then coming into general use and created a need for valves, piping and fittings. The first large-scale adoption of central house heating and modern bathrooms came in the 1890's and further increased the demand for those products. Another stimulating influence was the general acceptance of electric lighting. Until then current had been generated largely by small steam-driven dynamos located in the factories where it was consumed.

As central power stations came into being bigger engines were required and, in turn, larger Crane fittings. Questions soon arose as to whether the greater metal surfaces would withstand the heat, corrosion and stress. To provide the answers Crane set up a chemical laboratory in 1888, the first in the Midwest, and in 1890 hired a metallurgist to insure the production of iron castings of 20,000 psi tensile strength. It was common practice at the time to appraise the quality of pig iron by examining the color and grain structure as revealed by fresh fractures.

Soon the compound engine came along, with operating steam pressures up to 250 psi and raised new problems relating to the strength of metals and their resistance to greater expansion and contraction at higher temperatures. To be on the safe side, Crane began adding 20 percent of Bessemer steel to high-grade pig iron, thus increasing the ten-

sile strength from 20,000 to 30,000 psi.

A little later steel valves were needed to meet still more rigorous conditions, and as Crane wasn't satisfied with the castings he was buying he built his own steel foundry in 1907. There he turned out high-quality steel in a side-blown converter, the first one to be utilized for the purpose in the Chicago district. Some of his early procedures paved the way for present standards. Before 1900 he began to use gauges for checking threads and worked out many details for the manufacture of gauges. He originated the practice of tapping and gauging steel flanges, and contributed the first mathematical curves on the behavior of metals at varying temperatures.

Crane Co. has at times added new products to its established lines. Some of them have been retained, others discontinued. In the 1860's the firm began to make small steam engines to operate water pumps. Next came double reversing engines for coal-mine hoists and then blowing engines for blast furnaces— forerunners of today's centrifugal blowers. As elevators of that period were driven by steam engines, Crane entered the business in 1867 and was a leading manufacturer for 30-odd years.

Eleven types of freight elevators were built, and passenger lifts were introduced in 1872. To prevent heavy descending loads from running away with the engine, Crane devised a valve arrangement that caused the engine to become a re-

tarder whenever a dangerous speed was being approached. Later, the company constructed electric elevators with speeds up to 1000 feet per minute, as well as hydraulic and plunger types. Some are still in service.

A steel-mill engineer who saw a Crane elevator in 1870 realized that the principle could be applied to hoisting materials into blast furnaces, which are charged from the top, and he got Crane to make such a carrier. From then on until the firm gave up its elevator business it built 95 percent of the hoists used in the United States for that purpose.

In the 1880's reversing engines were supplied to steel mills for operating rolls, and in 1895 the Carnegie Steel Company alone had 100 Crane engines. Other things manufactured at times in the past included journal boxes for freight cars, metal trim for steam engines, and railroad airbrake systems. The latter were made for only two years, being discontinued in 1893. This policy of diversification continues today. Although Crane hasn't been in the metal-pipe business for some years, it recently entered into the production of polyethylene pipe in sizes from 1/2 inch to 2 inches, together with fittings. Another new field is the manufacture through Hydro-Aire, a subsidiary of Burbank, Calif., of electric and pneumatic equipment for airplanes.

Crane is also one of the leading concerns now furthering the development of the promising wonder metal, titanium. In January of this year its subsidiary, Cramet, Inc., began operating a \$25-million ore-processing plant at Chatta-

nooga, Tenn. During the next five years it will turn out 30,000 tons of titanium sponge, of which the Government has offered to buy up to 7500 tons at prices ranging from \$4 to \$5 per pound. A large percentage of the metal will go into Air Force planes where its light weight and high strength are of advantage. Its use instead of steel might reduce the weight of a jet engine by 300 pounds and permit the craft to carry 50 additional gallons of fuel.

The company expects to get titanium ore from its deposits in Canada and from 50,000 acres of beach sands on the Florida Gulf Coast. In processing the ores, Cramet will recover sizable quantities of some minerals that are now comparatively rare and are in increasing demand. Among them are zircon, cerium (used in cigarette-lighter flints), thorium and various fluorides and oxides.

Richard Crane was one of the first industrialists to introduce humane practices in his factories. The firm maintained a full-time medical department prior to 1900. Before it instituted a regular pension plan, Crane pensioned certain employees with his own funds. In a day when accidents in industry were taken for granted, he crusaded for safety, and insurance companies sent representatives around to see why the accident rate was so low. As early as 1897 he insisted that goggles be tried out in the foundry, and in the next year they were adopted virtually throughout the plants.

Crane opposed higher education vigorously because he felt that the money it cost should go towards extending basic



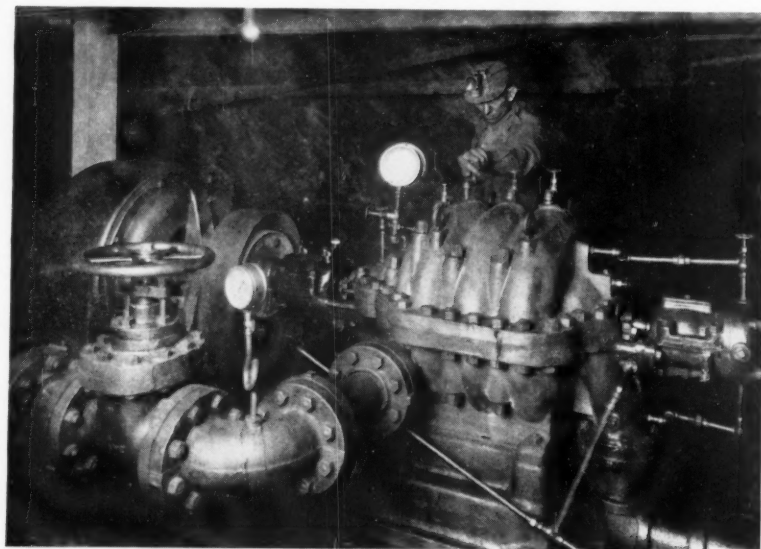
MODERN CRANE CONVENIENCE

Plumbing fixtures, for which the average American knows the Crane name best, weren't added to the firm's lines until 1895, forty years after it began to do business. Now it is known as the company that "makes everything and the kitchen sink."

training for the masses. On the other hand, he introduced manual training in the Chicago schools in 1891, even buying the tools and paying the instructors. He established scholarships under which teachers could specialize in manual training and the household arts. He spent \$80,000 of his own money before he could convince the board of education that it should take over the program. In the end, however, the board passed a resolution thanking him for his efforts. Crane Technical High School, one of Chicago's largest schools, was named for him.

Crane was democratic in an era when most industrial leaders were not. He refused to have a private office and kept his desk among his employees, in the open. He was lenient in many ways, but would not tolerate dishonesty. There is a story of four of his office workers returning late from lunch one day. They obviously had been drinking. When he asked each in turn if that was true, the first three denied it and were summarily discharged. The fourth man admitted the charge and was retained with a mild reprimand. Crane considered lying worse than drinking. He often condoned mistakes, saying that it was the company's job to make men efficient in their work.

Although few men of his time played golf, Crane somehow acquired a liking for the game. He didn't care for baseball, but even so bought suits for the Crane team. Physically, he was tall, and he remained strong and straight to the last.



TYPICAL VALVE SERVICE

Crane valves and pipe fittings may be found wherever liquids are pumped or steam or compressed gases are transmitted. This picture of an Ingersoll-Rand mine pump, taken underground in the 1920's, shows a Crane valve and pipe fittings at the left.

COLORADO'S FABULOUS

'MILLION DOLLAR' HIGHWAY

AMY PASSMORE HURT



MAINTENANCE BASE

To keep the highway open the year round in the face of heavy snowfall, maintenance crews of the Colorado State Highway Department are spotted at strategic locations. Here is the camp at Red Mountain Pass.

YOU have to borrow words such as "spectacular," "stupendous" and "breath-taking" from the vocabulary of a Hollywood press agent to describe one of the few highways in the United States that truthfully can be called adventurous motoring.

Not that Colorado's "Million Dollar Highway" is dangerous—it isn't. Even a woman can drive it. But it isn't advisable to do so at night, during a snowstorm or when the pavement is icy, unless you have chains. At any time you'll enjoy a real sense of adventure traveling along the 2-car-wide pavement that spirals and twists, dips and rises, glides and flattens like a roller coaster. You will lose your breath a bit when you go over the shelf-like section that was literally blasted out of the solid-rock mountain-side, and suck it in sharply when you feast your eyes on snow-capped peaks, falling waters, lakes, grassy canyons and what appear to be toy villages far, far below.

Officially, the Million Dollar Highway—U.S. Highway 550—extends from Durango to Montrose, Colo., but the most spectacular stretch is that which connects the historic old mining towns of Silverton and Ouray, a distance of 24 miles, though it seems longer. Opened in 1882 as a toll road by its builder Otto Mears, an enterprising little Russian, it was christened the "Rainbow Trail" possibly because of the riot of color Nature presents throughout its length. Part of the highway follows the roadbed of the early Silverton Railroad. Both were es-



PHOTOS, COLORADO STATE HIGHWAY DEPARTMENT

SHELF ROAD

A stretch where the highway was wrested from solid rock with drills and dynamite. Taken in March, this picture provides evidence that winter lingers long in this high-altitude area.

tablished by Mears, together with half a dozen or more other roads, all for the purpose of making the mining of low-grade ores profitable in this section of Colorado in the boom days.

The name Million Dollar Highway was given to the road in the early 1920's when the cost of reconstruction was set at that figure. Currently, a 6.7-mile unpaved stretch between Red Mountain Pass and Ouray is being widened and surfaced at an outlay of half a million dollars! Plans now underway include paving the one remaining graveled section over Molas Pass as soon as possible.

The main reason why these improvements have not been made before is because the Colorado Department of Highways has been handicapped by a lack of time. Disliking to work on the road during the tourist season, it finds itself with a few weeks each spring and fall when the weather is mild enough at an altitude of 10,000 feet or more to proceed with construction. Incidentally, there is at least one uranium claim now running

across the state highway. So far it has not been developed, and the problem of what will happen when mining starts and tunnels are driven under it hasn't been decided, according to Colorado highway officials.

Even under the best of conditions, the highway is a challenge to modern engineering. You think about that as you leave the fertile farm and cattle country north of Durango and start the pulse-quickenning climb up the superpaving to Coalbank Hill, 10,640 feet high. At the bottom of the hill you cross Lime Creek and again start to rise to rugged Molas Pass, 10,901 feet above sea level, to view the awesome and soul-stirring grandeur of the San Juan and Needle mountains. On descending, you pass jewel-like Molas Lake with its backdrop of snow-covered mountains. A mile farther on you catch your first glimpse of Silverton in the valley beyond and below the highway.

North of that old mining camp you snake up the long, curving road to the

summit of Red Mountain Pass from which point you see the three Red Mountain peaks loom skyward well over 12,000 feet, a never-to-be-forgotten sight. Colored a lovely glowing red from iron pyrites and with the glittering snow frosting their sides, they present a picture that will cause tears to sting your eyes. From the pass you swoop down a few miles to where a concrete bridge over Bear Creek reveals a sparkling, shimmering cascade of water that falls more than 200 feet to the misty valley below. There you will find the rather insignificant Otto Mears memorial tablet that may make you wonder why the fabulous highway was not given the name of its founder.

Two miles south of Ouray you go through a short tunnel which was blasted out of solid granite in 1924 when the road became a public highway. From the top of the black-walled Uncompaghre Can-



CONSTRUCTION SCENES

Upper picture was taken in the autumn of 1954 on Red Mountain Pass while preparations were in progress for paving the one remaining dirt-surfaced stretch between Ouray and Silverton. Most major work must be crowded into the brief span between the departure of tourists and the onset of early winter.



OURAY — 'VILLAGE IN A CUP'

Named for a benign Indian chief, this attractive town is almost surrounded by colorful mountains. Not far away is the famous Camp Bird Mine from which Thomas Walsh took a fortune before selling to British interests. The most spectacular stretch of the Million Dollar Highway lies between Ouray and Silverton.

yon you look down upon Ouray, hundreds of feet below. It looks like a miniature Swiss village, completely surrounded as it is by towering mountains. Beyond this little "village in a cup" the road gradually begins to level off as it passes through the beautiful Uncompaghre National Forest on its way to the booming city of Montrose where the famed Indian chief Ouray and his wife Chipetal made history in the rich and peaceful valley roundabout.

There the Million Dollar Highway ends, but it is not the end of the emotional impact you've experienced driving over it. That won't leave you for many, many months — if ever.

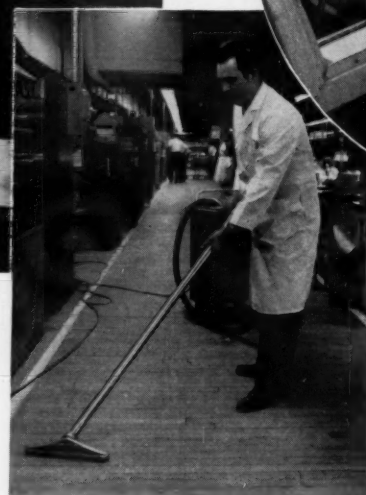


SEVEN hundred and fifty "Snow Whites" (there are no dwarfs) assemble miniature and subminiature electronic receiving tubes in a spotless pressurized enclosure in General Electric Company's factory at Owensboro, Ky. In the year the facility has been in operation the number of tubes rejected because of intermittent short circuits caused by the inclusion of dust and lint has been reduced by two-thirds.

Wearing white lintless nylon and dacron uniforms, the workers assemble "Five Star" tubes under glass hoods in a separate factory building. All who enter or leave the assembly area must pass through a 15x12-foot air lock. Every minute 70,000 cubic feet of filtered air is pumped into the department and 40,000 cubic feet is taken out through a system of ducts. The difference of 30,000 cubic feet escapes and effectively dust-seals the lock and any possible cracks or other openings.

Upon entering, each person receives a mild vacuum cleaning as he or she walks over a floor grating through which the air is exhausted. But before that, the employees must hang their outer garments in a special cloakroom adjoining the air lock. To reduce traffic, messengers deposit all mail for the department in a rack in the lock, where it is picked up by a "Snow White" and delivered to offices located in the pressurized section but closed off from the actual working area.

When the program was initiated, the company issued cash certificates to each operator that covered the major part of the cost of two uniforms. Local mer-



chants were given advance notice so that they would be able to fill the demand for the special clothing. The women employees have a choice among twelve styles of dresses. Male supervisors wear a white dacron or nylon short-sleeved sport shirt, blue dacron pants and nylon socks; ties and belts of nylon or dacron are optional. As no one is allowed to go into the department in lint-shedding clothing, visitors must don one of the white lintless coats that hang in a steel locker in the air lock.

The personnel has been thoroughly indoctrinated in the necessity for extra cleanliness. Maintenance men alternately go over the entire floor with industrial-type vacuum cleaners and chemically treated cloths. At any time of day the floor could pass a white-glove inspection. Each operator thoroughly cleans her own work station twice daily. Every hour she replaces the rubber cots she wears on all fingers to protect the tube mounts against moisture and foreign substances.

All assembly mounts are covered with special protective glass-windowed hoods in which the operator can use her hands with complete freedom and have an unimpaired view of her work at all times.

Operation 'Snow White'



SPICK AND SPAN

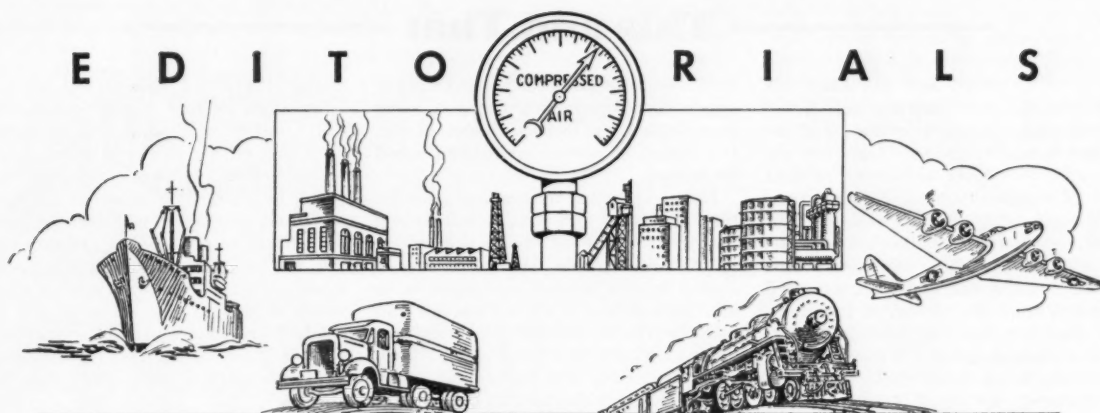
The girl shown entering the door has just passed through the air lock, where a down draft through the grated floor divested her of lint and dust particles. The view above shows her welding a small tube mount held in a jig under protective glass. Men with vacuum cleaners go over the floor at regular intervals.

The conveyors that move the tube mounts along the assembly line are constructed of rubber, which gives off no lint and can be cleaned easily.

Prior to actual assembly, all grid sub-assemblies undergo special cleaning to free them of dirt, dust and lint and are then rinsed in distilled water and twice in methanol. The latter liquid is used so the grids will dry faster. Following further drying in an electrically heated oven, the grids are sorted and inspected for mechanical perfection and for lint, dirt and dust particles. After that they are placed in glassine bags which are stapled shut to keep them lint and dust free during transportation to the mount line.

Operations under the glass hoods begin with cage assembly, the components being positioned in precision-made jigs. After pin connections are welded—also under glass—each mount is inspected under a 10-power binocular microscope for chipped pieces of mica, weld splashes, mechanical failure such as a break in the wire, and for lint and dust. The final job involves placing the mount in a coil that demagnetizes the metal parts while a stream of compressed air blows off any foreign particles that may be clinging to it. Then the finished product receives a second complete microscopic inspection and is ready for insertion in the envelope.

EDITORIALS



THE GRADUATING ENGINEER

HUMAN services command higher prices than ever before. When most people were slaves, they worked—hard and long—for food and lodging, both usually of poor quality. Men were on the same plane as draft animals. Since then the lot of the laborer has improved amazingly. The progress curve is filled with hills and valleys representing cycles of prosperity and depression, but its course is definitely upward.

It is axiomatic that higher pay calls for greater production. A day's work for a day's pay is an old adage. Yet men in shops do less heavy work all the while. Machines now do what hands used to do and do far more of it in an hour or a day. That's why employers can pay men better than they used to.

The white-collar worker doesn't have things that easy. There are machines to write letters, to add and subtract and compute, but a mechanism that can reason and exercise judgment is still to be invented. Only the human brain can do these things, and it alone can design the wonderful production machines and processes, determine what is wrong with them when they break down and put them in good order again. It follows that there never was a time when brains were so much in demand, and that explains why current college graduates, especially the technically trained ones, are being snapped up at stipends that few men ever lived to attain 50 years ago.

Most of the colleges that turn these boys out into such lush industrial pastures are aware of a deep obligation. They realize that their products bring a high price and should, consequently, be of high quality. They try to see that their graduates are worthy of their hire. Thinking along these lines, Pennsylvania State University has set forth in a newsletter issued by its Mining Society some of the major specifications for engineering college graduates. These are things "industry looks for and expects to get" from the nation's campuses.

We read, for instance, that the boys must be adaptable—to be able to adjust

readily to new environments. This means avoiding preconceived ideas of life beyond the classroom so that a move into strange industrial surroundings will not be upsetting.

Next on the list is enthusiasm. Recruiters for industry are searching for boys who are keenly interested in what they do, in world problems, and in life itself. An inspiring professor or two can do much to kindle such zests.

Industry, too, expects the graduate to know how to use his knowledge, to separate the wheat from the chaff or, as the newsletter puts it, to "use that too-little-employed effort called thinking and come up with a decision, conclusion or reasoned course of action."

Attitude towards others also is emphasized—"places in life where the individual can turn his back on people and still make a living grow fewer each year. A personality that attracts, not repels, others can serve as one of the great cornerstones of a successful life."

Last but not least on the list is working habits. Industry can reap little profit from the lad who must learn how to work effectively after he gets a job. College is expected to have disciplined his mind if it has done nothing else. "Snap" courses won't do it, but one that is difficult to master and seems useless at the time may prove to have been extremely beneficial in this respect. The boy who knows how to surmount obstacles is the one who usually climbs the ladder. There are more and weightier problems there, but also more satisfying rewards.

These, then, are the requirements for success, as one college sees them. Most industrial leaders would agree that the youngster who possesses these qualifications has a good chance of winding up in the "front office." No mention is made of the importance of this or that course. It is taken for granted that the youths will have absorbed a goodly amount of the technical knowledge to which they have been exposed. In addition, and even more important, industry asks that the graduate's schooling "add to his mental stature, not take away or stifle it."

WHY THEY QUIT

IN AN effort to find out why factory workers quit their jobs, a researcher in industrial psychology talked to a great many of them and also to the persons designated in 48 different companies to conduct "exit interviews" with departing discontented employees. Of every 500 who quit, 189 said the pay was unsatisfactory, 81 cited transportation difficulties in getting to and fro, 73 didn't think the chances of bettering themselves were adequate, 69 didn't like the working conditions, 64 said their health was poor and 24 gave other reasons.

Actually, the psychologist, Dr. Willard A. Kerr of the faculty of the Illinois Institute of Technology, believes that many workers are mentally confused and don't know exactly why they quit, although they won't admit this when asked and give the first excuse that comes to mind. He thinks there is often an intertwining of reasons behind the decisions to leave. The affected persons sometimes become emotionally upset and "build up" false cases in their minds.

To illustrate: Workers who have undependable transportation facilities or who live far from their jobs may be late with considerable frequency. The supervisor, lacking knowledge of the cause of the tardiness, may catalogue such an employee as unreliable. The worker gradually senses this distrust and develops, in turn, a feeling of resentment and a lack of confidence in management. Then he quits because "he doesn't like the working conditions."

Doctor Kerr says it costs industry from \$80 to \$600 every time an employee leaves, and there is, consequently, a sound monetary reason for endeavoring to reduce the number of departures. It is even more important, however, to find out what motivates these people, because the same dissatisfactions are likely to be harbored by many of the workers that remain. Determining and removing the underlying causes can both reduce the turnover and improve the morale, efficiency and company loyalty of the employees that stay.

This and That

Sell Rock And Then The Hole

They say you can't eat your cake and have it too, but some operators of underground quarries are doing something of that sort. Thompson-Strauss Quarries, Inc., of Kansas City, Mo., for example, has marketed around 20 million tons of limestone and is now selling the space it came out of. In extracting the stone, it created a cavern more than 100 acres in extent. The floor is practically level, and overhead is an average of 175 feet of cover. The temperature inside varies little from 55°F during the year, and there is no moisture to contend with. Realizing that these conditions made the space suitable for storage purposes, the management surveyed local needs along that line and found that there was a shortage. Thereupon, it formed a subsidiary storage company and started converting approximately 8 acres for storing both frozen foods and dry commodities.

The solid limestone roof, with spans of 40 feet between pillars left in position, was bolted up on 4-foot centers so it would better withstand shrinkage resulting from refrigerating temperatures. Floor irregularities were evened up by pouring 5000 cubic yards of concrete. A 400-ton ammonia-brine refrigeration system was put in to bring the temperature down below freezing. When it was idle for 60 days the temperature rose only 3°, as compared with a normal rise of 5° in 24 hours in the average warehouse above-ground.

A railroad spur that runs directly into the plant through one of the four entrances can accommodate eighteen freight cars, and lift trucks take merchandise from them to storage areas, none of which are more than 150 feet away. An unloading dock for truck trailers has space for fifteen units. For dealers who wish to quick-freeze produce and store it there is a freezer plant with a daily capacity of 60,000 pounds. The cost of converting the quarry was \$4,000,000. Production of limestone from other parts of the deposit is continuing.

★ ★ ★

Resistant Ceramic Coatings

Ceramic coatings that are unusually resistant to heat can be applied to metals, glass and ceramics themselves by a new process developed at Armour Research Foundation of the Illinois Institute of Technology, Chicago, Ill. Called "Flame Spray Ceramics," they are formed by feeding powdered materials such as aluminum oxide or zirconium oxide through a flame gun. The process differs from ordinary ceramic coating techniques in that the base material does not have to

be heated. Details of the process and the apparatus have not been disclosed, other than to liken the method to metallizing. It is stated, however, that no compressed air is used.

It is claimed that the alumina is harder than tool steel and that it will adhere firmly to the base material in thicknesses up to about ten mils (0.01 inch). Metals coated in this manner are expected to find application in rocket nozzles and other products that have to resist the erosive action of high temperature. They may be suitable also for making pump impellers, fan blades and turbine wheels,



DEMONSTRATING PROCESS

The receptacle contains powdered ceramic material, which is fed through a flame to produce a sintered coating that may be built up in thickness, as desired.

as well as piping that is subjected to cavitation. Continental Coatings Corporation, of Chicago, has obtained an exclusive license to use the patents, with authority to sublicense.

★ ★ ★

To Drive Tunnels In Ice

Hoping to avoid the difficulties of building and maintaining surface roads in Greenland under adverse Arctic weather conditions, U.S. Army Engineers will dig 15 miles of trial subways through the ice cap this summer. If the scheme is successful, several hundred miles more of these undercover travelways will be excavated in and between military bases.

The construction procedure is simple and inexpensive. A trench, say 3 feet wide and 15 feet deep, will first be dug in the ice. The lower 12 feet of the opening will next be widened out equally on both sides to a total of 12 feet. The re-

sulting 12x12-foot gallery will have a 3-foot-thick ice roof, except for the central 3-foot opening which will be closed by slicing off big blocks of snow at the surface and sliding them down until they wedge in place. It is expected that any remaining depression will soon be filled by drifting snow and that pressure and cold will seal the roof section into a solid block of ice. The ice that is to be excavated in driving the subways will be crushed and blown out by equipment such as is commonly used for icing railroad cars carrying fresh fruits and vegetables.

Earlier experimental tunneling in ice to depths of 150 feet has shown that such lateral openings contract vertically at the rate of about 6 inches a year. Consequently, if the subsurface highway network proves to be feasible, it will occasionally be necessary to trim either the roof or floor.

★ ★ ★

Big Job Looms In India

Building a steel mill is a huge job anywhere, but in India the unusual conditions that prevail make it a truly monumental task. As a part of its second 5-year plan, that country expects to begin construction next year in Madhya Pradesh on an integrated steel plant that will be a little less than half the size of United States Steel's new Fairless Works near Morrisville, Pa. The general manager of the project, S. N. Mehta, recently said in Delhi that 26 square miles of land will be required for the mill site alone, with 10 square miles more for a township. In all, he predicted that 100 square miles, embracing 50 villages with a combined population of 60,000, may have to be acquired. The establishment will be able to turn out annually 720,000 tons of finished steel, 200,000 tons of plate and 100,000 tons of pig iron. It will be built with the financial and technical assistance of Russia.

★ ★ ★

Oil-free Air Aids Dairies

The dairy industry has liberally accepted the idea of using compressed air to agitate milk while it is being held in big storage tanks awaiting processing. Small nonlubricated compressors were first applied in 1946 by the Dairymen's League Cooperative, a large supplier of milk to New York City, and then gradually adopted elsewhere. Ingersoll-Rand Company, which introduced the compressors for this service, states that air agitation is now common practice in dairies in 36 states and several provinces in Canada.

The compressor is a small air-cooled, motor-driven unit (with air, only about ½ hp is needed as compared with up to 2-3 hp for driving mechanical paddle-type agitators). To make sure that the air bubbling up through the milk will be free from oil, the compressors have carbon piston rings that require no lubrication. The air is also filtered prior to application.

Dairies and other plants that manufacture ice cream also are using these compressors increasingly. Some air is introduced into the finished product to give it a smooth, creamy texture. Small, diaphragm-type compressors, which likewise need no lubrication in the compression chamber, are sometimes employed,

but their limited capacity calls for the installation of one for each freezer. Companies have overcome this situation by providing a nonlubricated reciprocating machine large enough to take care of the demand of the entire plant.

★ ★ ★

**Saving
The Last
Drop** Before the price of coffee zoomed nobody counted the cost if a waitress accidentally spilled a cup of the popular brew, but now even industry is concerned with conserving it right down to the last drop. The Economy Faucet Company has gone so far as to figure that the average cup con-

tains 1250 drops and that an urn faucet which leaks one drop per second will waste a cupful in 21 minutes. Leakage is normally in the form of "after-drip" which takes place after a cup has been drawn because some liquid is temporarily trapped by vacuum when flow ceases. To eliminate this, the firm made a detailed study of faucet design and came up with one of forged bronze shaped to prevent the formation of a vacuum and so smooth inside that coffee grounds won't linger there. Two clean-out plugs also facilitate the removal of any flavor-affecting film that might form inside. It looks as though the cup of coffee, now that it has joined the 5-cent cigar in limbo, is getting some real attention.

Fruit Grower Likes Pneumatic Tilters

MUCH of the fruit grower's work must be crowded into a short season, which means that he has to garner and handle his crop expeditiously for processing, packing, or storage. A good example of facilities now used for this purpose is found in the receiving stations of the California Prune & Apricot Growers Association, of San Jose, Calif. There load after load of ungraded dried fruit is hauled in from the fields in portable wooden bins with a capacity of approx-

imately 2500 pounds each. Upon arrival, fork-lift trucks pick up the boxes and place them on elevated dumpers flanking conveyors that carry the prunes or apricots to washers and graders.

The dumping units were designed by the association, whose product bears the familiar name Sunsweet. They consist of stall-like metal bins, open at both ends for ease of access, and are mounted on sturdy framework. Tilting is effected by a pneumatically powered arm and is

controlled by two snubbers. In commenting on the equipment, J.D. Cantoni, superintendent of production, said:

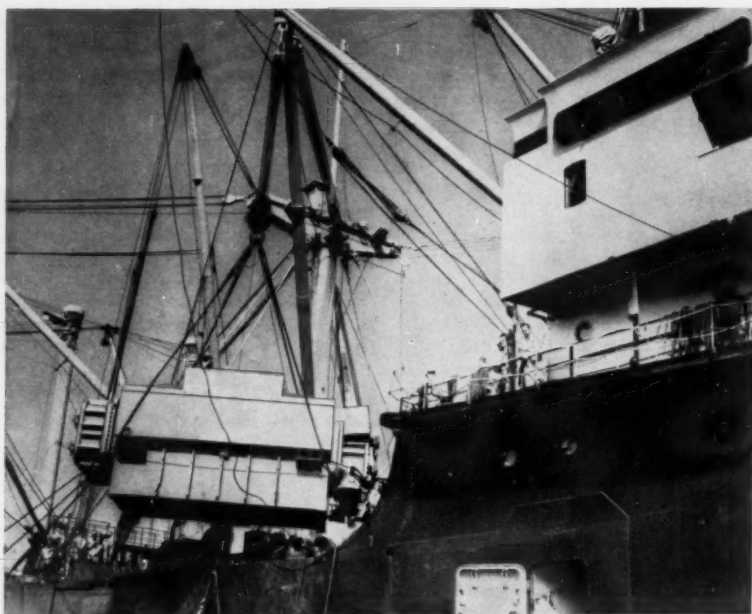
"We like compressed air for this application, as one air compressor will serve a number of tilters, providing a relatively simple source of power. It gives us a fast rotation when needed, and most important, a four-way air valve enables the operator to rock the bin back and forth to jar the fruit loose, facilitating emptying."



GROUP OF PNEUMATIC TILTERS

All the plants of the California Prune & Apricot Growers Association are equipped with a line-up of dumpers much like that pictured here. The fork lift truck at the right is putting a full box into the open-ended bin and will remove

the empty. Before the box is tilted, it is secured by a metal bar to hold it in place. The unit at the extreme left plainly shows the air cylinder that actuates the lifting arm and, beneath it, the two snubbers.



Heaviest Shipment to Ciudad Trujillo

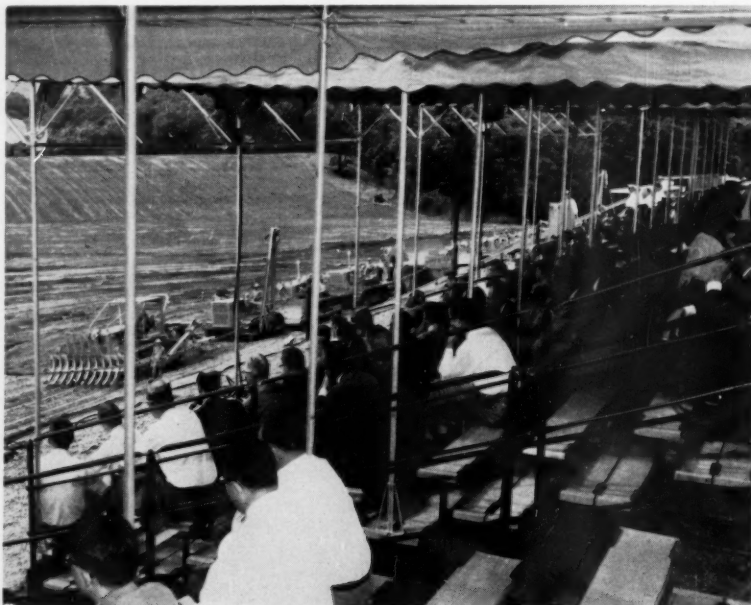
THE accompanying picture shows the heaviest piece of equipment ever to be unloaded onto a pier at Ciudad Trujillo, capital of Santo Domingo (Dominican Republic), the first settlement to be established by Europeans in the western hemisphere. The object is a surface-type steam condenser for use with a 12,650-kw turbogenerator housed in an addition to the power plant of the Corporación Dominicana de Electricidad, which supplies Ciudad Trujillo and the surrounding area with electricity.

The Ingersoll-Rand condenser, which is technically described as a 2-pass, vertically divided unit with 13,000 square feet of cooling surface, is 27 feet long, 11 feet 3 inches wide and 11 feet 10 inches high and weighed 105,200 pounds as shipped. It was transported from the United States on one of the boats of the Bull Shipping Company. Upon arrival in Ciudad Trujillo, it was swung from the deck by the ship's winches and tackle and lowered onto a trailer truck that hauled it to the plant half a mile away.

At the powerhouse site, the condenser was slid from the truck into the excavation that had been prepared for its foundation. Once in place it was raised in stages by hydraulic jacks and supported on timbers that were cut to size and positioned to leave enough room so that the permanent foundation could be constructed around them. As installed, the unit rests on spring supports and is directly under the turbogenerator, which was provided by the International General Electric Company.

Stone & Webster Engineering Corporation of Boston furnished the design

and procurement services for the power-plant addition, which was built by Stone & Webster Construction Company. The new facilities were placed in operation in April 1955.



WATCHING A \$2-MILLION SHOW

Scene at Peoria, Ill., last month when Caterpillar Tractor Company showed off \$2 million worth of current and forthcoming models of roadbuilding machinery. More than 100 representatives of the nation's trade press previewed the parade, which was arranged primarily for 500 Caterpillar distributors and field men. They also toured the manufacturing plant, including the 21-acre diesel-engine shop that employs 3000 persons. The visitors were informed that tractor power has doubled in twenty years but weight has increased only 15 percent.

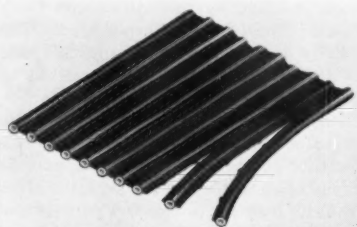
New Plating Process

PREPLATING steel with copper or nickel, or both, is eliminated in the case of a new chromium plating process that is said to insure much higher corrosion resistance than any now in use. Developed by United Chromium, Inc., and known as Unichrome Crack-Free Chromium, the work is done with standard equipment and procedures. After the special chromic-acid bath has been prepared, the catalyst concentration is automatically regulated and the temperature closely maintained at 150°F. The deposit has a light-gray matte finish and can be given a high luster by buffing.

The Maytag Company is the first to apply the process on a production basis following extensive laboratory tests and pilot-line operation as well as exposure of plated specimens to 100% humidity and 120°F for more than twelve months. The plant is equipped with a 9-tank automatic machine that plates fifteen steel or solid-copper parts for washers and driers with 0.0003 inch of chrome at a speed slightly better than 0.0009 inch per hour at a current density of 3 amperes per square inch. The deposit is said to be free of imperfections that will allow corrosive agents to reach the underlying metal. Other advantages claimed for it are: good adhesion and wear resistance, low coefficient of friction and superior ductility.

Industrial Notes

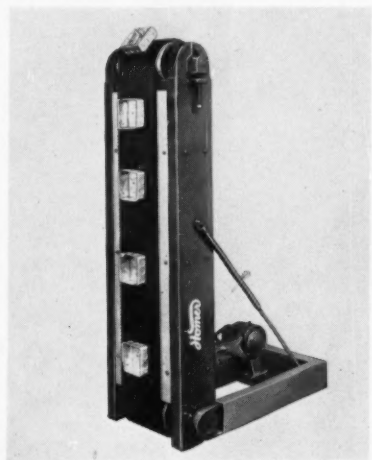
Small-diameter copper or aluminum instrument tubing is now available in multiples of ten each completely encased in a chemically resistant plastic sheath 0.02 inch thick and attached to the adjacent tubes by a perforated plastic web. This construction permits stripping off one or more without the use of tools and without damaging the protective



coating on any of them. Made by Dekoron Products Division of Samuel Moore & Company and designated as "M" Ribbon, it is now available in the following standard sizes: $\frac{1}{4}$ inch outside diameter in copper or aluminum tubing with wall thicknesses of 0.03 and 0.32 inch, respectively; $\frac{3}{8}$ inch OD in copper or aluminum tubes 0.032 and 0.035 inch thick. The covering of polyvinyl chloride is said to eliminate frequent tube replacement in service, and because the ribbon comes in lengths of 500 feet there are few if any joints to cause trouble. The over-all width of ten $\frac{1}{4}$ -inch tubes is $4\frac{1}{8}$ inches; of a harness of $\frac{3}{8}$ -inch tubes, $5\frac{1}{8}$ inches.

Circle 1E on reply card

Shops or plants manufacturing ferrous products have available a new kind of materials-handling equipment—a magnetic conveyor that stands on end and permits close grouping of machines. Developed by The Homer Manufacturing Company, Inc., and known as the Space Saver it can be used to carry such parts



as nuts, bolts, nails, bottle caps, tin cans, stampings, etc., at an angle as steep as 90° , the belt holding them securely regardless of the incline. It can also be utilized to remove scrap from receiving pits, stack flat pieces, and feed machines, the speed of the latter and that of the conveyor being synchronized. The feed point may be at floor level or anywhere throughout the height of the Space Saver, which is furnished in stationary or portable standard or custom-built types for service with existing or new production lines.

Circle 2E on reply card

For industrial use where heavy liquid drums or barrels of products, metal chips, refuse or the like must be handled there has been developed a cart or truck that picks them up, holds them and unloads them without the worker touching them, according to the manufacturer—Valley Craft Products, Inc. Provided with a specially designed shoe, the operator causes an automatic spring-actuated bar to slip a hook over the edge of the container when he brings the cart in upright position against it. Then he tips the truck, rolls it away and stands it on end at the unloading point, thus releasing the drum so it can



slide off the shoe. Designated as Valley Barrel Cart Model 600, it needs only enough room in which to maneuver, an advantage where barrels are in touch with one another in storage. The truck is equipped with a kick stand so that it can be put in a vertical position when not in service.

Circle 3E on reply card

For direct spindle tapping without the use of tapping heads or clutches, The Bellows Company has introduced a controlled air-power device that minimizes installation problems. The unit consists essentially of a Bellows-Locke drill with a special in-line mounted Hi-slip motor for 220/440-volt 3-phase operation and



A COMPLETE LINE OF AIR CONTROL EQUIPMENT

Including precision-made **HEAVY-DUTY**

AIR MOTORS

WITH "SEALED-IN LUBRICATION" Pat. Pend.

Wide choice of electric and/or air controls and mountings. For air pressures 5 to 200 P. S. I.
Bores: $1\frac{1}{2}$ " - 2" - 3" - 4" - 5"
Strokes: $\frac{1}{2}$ " to 72"



"Sealed-in Lubrication"
Assures low break-away on long idle units — ample sealed-in oil for thousands of cycles without attention.

You Are Invited To Consult Our Engineering Department
freely on all air automation or replacement problems. Trained factory personnel available nationally.
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COMBINATION VALVES
Panel units, hand and foot operated valves. Wide range of models.



Lehigh Minor AIR VALVES and CYLINDERS
Low priced, light duty. For air operated jigs, fixtures, high speed operations.

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EASTON, PENNA.

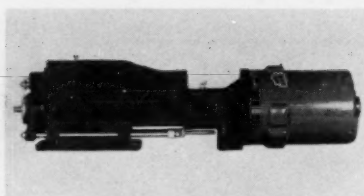
"Sealed-in Lubrication"

AIR CYLINDERS
 $1\frac{1}{2}$ " to 8" bore

3 or 4-Way

AIR POWERED VALVES

Air or electrically operated. J.I.C. Standards.



is provided with a magnetic motor-reversing contactor, line overload protection and control transformer. The Model DT-5E features rapid air-powered approach to the work and smooth hydraulic feed at any preset rate desired. Spindle traverse is adjustable from 0 to 3 inches and thrust is approximately three times the applied air pressure. Taps range in size up to $\frac{5}{16}$ -18 or $\frac{3}{8}$ -24 in mild steel, and any holder that will fit the spindle taper (Jacobs No. 2) may be used. The device may be mounted at any angle in any plane and is designed for continuous duty at rates up to 60 reversals a minute.

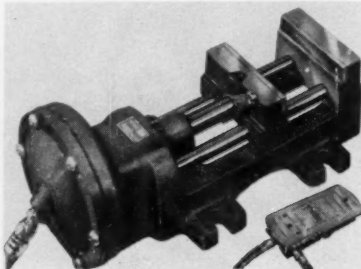
Circle 4E on reply card

Clerks who handle and sort papers and currency have to wear rubber fingers or moisten fingertips by means of a water-soaked sponge. Both procedures have been improved upon as to efficiency and cleanliness, we are told, by Lee Products Company which is distributing a small metal box with a sliding top containing Sortkwik—a hygroscopic preparation that looks like gelatin. Drawing

a finger over it leaves it with a thin tacky film that soaks in and is said to pick up many papers before it has to be renewed. There is enough in a box to last about four months in normal service. The substance is harmless to the skin and washes off easily.

Circle 5E on reply card

Heinrich Tools, Inc., has announced an addition to its line of air vises for bench or machine mounting. Of larger capacity than the earlier models, the 44 is controlled by a foot valve and operated by a pneumatic cylinder with air at a maximum pressure of 150 psi. It



is said to exert a grip fifteen times greater than the air-line pressure. Holding power can be varied from a light to a tight squeeze by use of an optional air regulator. Clearance between jaws is adjustable up to $4\frac{1}{4}$ inches, and the sliding jaw has a maximum travel of

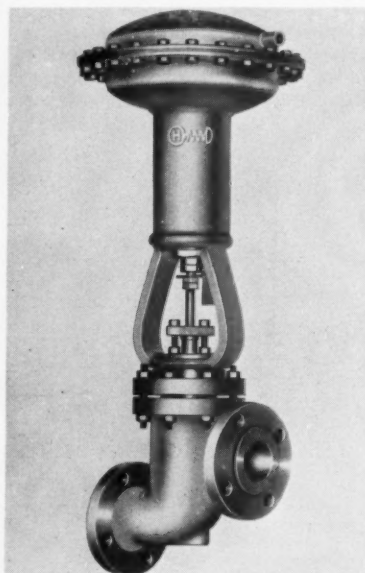
$\frac{3}{8}$ inch. The latter is mounted on two parallel bars to maintain alignment and is easy to set and lock. The air-cylinder is constructed of die-cast aluminum and, with its one-piece diaphragm, is completely encased. All working parts of the vise are protected from oil, coolant, chips and the like.

Circle 6E on reply card

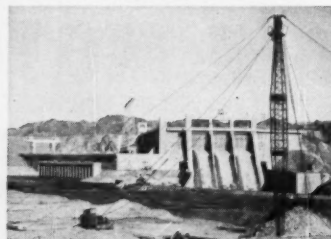
A compact auxiliary gas turbine that can supply either electric power or compressed air, or both simultaneously, has been designed by the AiResearch Division of The Garrett Corporation. The unit represents a departure in this field of turbomachinery and is reported to be a major factor in the remarkable performance of the U. S. Navy's Martin Seamaster. It was developed for this multijet attack seaplane, which may be called upon to operate thousands of miles from its base for protracted periods and must therefore carry its own source of pneumatic and electric energy. The small turbine provides compressed air to start the craft's main engines and generates electric power for emergency use in take-off or landing. Meantime it serves as a standby, ready to act should any overload or other emergency conditions arise.

Circle 7E on reply card

For use in the process industries where toxic or corrosive substances are handled, Hammel-Dahl Company recommends the new Standard 1000 Series in its line of control valves. Known as the Ultravalve, it is offered in three body styles of steel or alloy construction: offset (which is illustrated), angle and in-line. In addition to a Dahl seal in the bonnet it has a Bellows seal welded to the stem, thus offering double insurance against leakage. Other advantages



"WALKING" CABLEWAY REMOVES 75,000 YDS. OF ROCK AT DAVIS DAM



To deepen the Colorado River from Davis Dam to 2,000 ft. downstream, Grafe-Callahan Construction Co., employed a Sauerman Slackline Cableway in this unusual arrangement:

Mast and hoist of the 2-cu. yd. machine were mounted on wooden mats. Only four "steps" were required in covering the 2,000-ft. distance as the excavation progressed. Maximum span was 600 ft. A crawler crane, running on a 30-ft. cofferdam on the opposite bank, served as tail anchor.

Total excavation was 75,000 yds. of rock. Excavation depth ranged from 10 to 15 ft. to provide the 20-ft. channel depth and lower tailwater at the power plant for maximum effective head on turbines.

Sauerman Slackline Cableways range from $\frac{1}{2}$ to $3\frac{1}{2}$ cu. yds. in size—span water, bogs or pits at distances up to 1,000 ft. On the ordinary or the unusual job, these Sauerman Cableways are unexcelled for deep digging or handling rock, sand, clay, peat and ore.

Experienced Sauerman Engineers can solve your excavating problems. Write today. Request Catalog C, "Slackline Cableways" and also pertinent field reports.

SAUERMAN BROS. INC.

648 S. 28th AVE.

BELLWOOD, ILL.

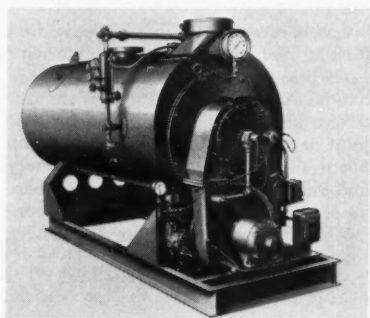
claimed for the series are ease of maintenance because all internal parts are removable through the bonnet; interchangeability of components among the three types; and self-drainage which eliminates need of frequent cleaning. Nominal valve sizes range from 1/2 inch to 6 inches.

Circle 8E on reply card

Super Powerhouse, a new insulating cement for service involving temperatures up to 1700°F, provides a smooth white finish when used either by itself on valves, flanges or fittings or to coat thermal insulating materials such as blocks and blankets. It contains long fibers of spun mineral wool and is applied by trowel. Spread 1/4 inch thick, 100 pounds will cover an area of 110 square feet. The cement is said to remain workable for an hour after mixing and water resistant after an initial set of two to three hours.

Circle 9E on reply card

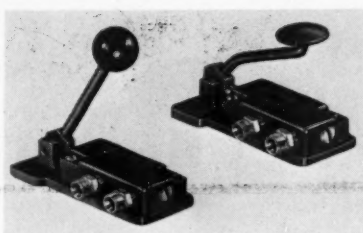
Plants that are heated by hot water and have occasional use for steam should be interested in a combination steam-hot water boiler being manufactured by the Cyclotherm Division of the U. S. Radiator Corporation. Burning light oil or gas, or a mixture of both, the unit is rated at 60 hp and delivers either 2480 gallons of hot water per hour with a 100° rise in temperature or 2070 pounds of steam per hour. Conversion from one to the other is effected by making a few adjust-



ments. Changeover to steam simply involves closing the main hot-water inlet and outlet, dropping the water level in the boiler and switching a control panel from "aquastat" to "pressuretrol." The generator is provided with dual controls and dual steam and hot-water take-offs.

Circle 10E on reply card

Shown in the accompanying illustration are two of three new air valves in W. R. Brown Corporation's Speedy line. The one at the left is manually operated and remains in open or closed position without the application of constant hand pressure. The other is a 3-way fingertip unit for presses, rams or air cylinders with a maximum bore



of 6 inches. Both have base plates with bosses for workbench or machine mounting. The third is an improved 3-way foot-controlled valve for use with a wide range of pneumatic devices. All have ports for 1/4-inch male hose connectors.

Circle 11E on reply card

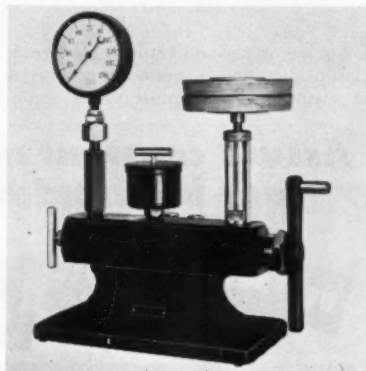
What are undoubtedly the world's heaviest glass windows have been cast successfully at the Corning Glass Works. Some of them are 6 feet in thickness and weigh 12 tons. They are nearly as dense as steel and contain lead to protect research and experimental workers on atom-powered airplanes from radiation.

A new plaster put on the market under the name of Lite-Wall by The Ruberoid Company is composed of gypsum and perlite aggregate. Blended in proper proportions at the factory, it needs only clean water for mixing on the job. It

can be applied to metal, masonry and gypsum lath and is said to be more workable than ordinary sand plaster and 50 percent lighter. Lite-Wall can be used for both the scratch and brown coat.

Circle 12E on reply card

To insure correct and safe functioning of some industrial equipment it is necessary periodically to check pressure gauges. For this purpose Amthor Testing Instrument Company has introduced



three improved models of its Dead Weight Tester for pressures up to 3000 psi, from 4000 to 6000 psi and up to 10,000 psi. They are guaranteed to be accurate within 1/10 of 1 percent of the

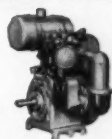
Most Specified for ORIGINAL EQUIPMENT POWER

WISCONSIN HEAVY-DUTY *Air-Cooled* ENGINES 3 TO 36 HORSEPOWER

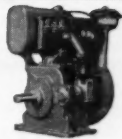
In the design, manufacture, and ultimate use-purchase of mechanized field and industrial equipment . . . Wisconsin Heavy-Duty Air-Cooled Engines are specified as Original Equipment Power Components to a greater extent than any other make of engine, within a 3 to 36 hp. range.

This dominant preference must necessarily be based on actual performance records of users . . . because Wisconsin Engines are not sold on a "price" basis. These engines have the inherent Lugging Power that stays with the job, eliminating "stop-and-go" delays, saving manpower and manhours . . . and delivering "Most H. P. Hours" of on-the-job service, with minimum servicing.

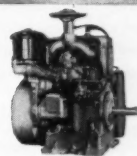
If this makes sense to you, let's get together. Write for engineering and descriptive data.



3 to 6 hp.



6 to 9 hp.



7 to 15 hp.



15 to 36 hp.



WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

A 7991-1/3

Circle 12A on reply card

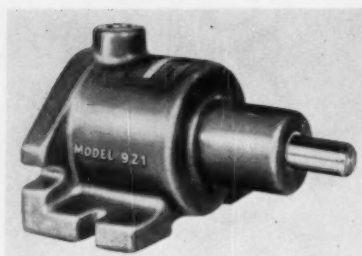
indicated reading. The instruments are easy to operate and packed with accessories in a metal carrying case.

Circle 13E on reply card

Synthetic ingredients are the base of a new cutting compound put on the market by Shell Oil Company. It dissolves in water, forming a true solution that is said to be safe, to have exceptional cooling properties and to prevent rusting. It is called Dromus Oil E.

Circle 14E on reply card

For use on jigs and fixtures, Modernair Corporation has announced a new series of spring-return, clamp-type air cylinders.



ders. Of 2-inch bore and 1- and 2-inch stroke, they have an over-all length of 4 3/4 and 5 3/4 inches, respectively, with the piston retracted. The latter is made

of stainless steel and operates in an Oilite bronze bushing that is locked to prevent drifting. Designated as the 900 Series, the cylinder is provided with a 1-piece aluminum casting which has a flat base to permit horizontal or vertical mounting and quick installation or removal by tightening or loosening bolts.

Circle 15E on reply card

Shown in the accompanying illustration is a new type of packaged rotating joint for air- or hydraulic-pressure applications where two or more members turn inside one another. The unit is available with single, double or triple rotating passages and is constructed so that there cannot be any thread strains

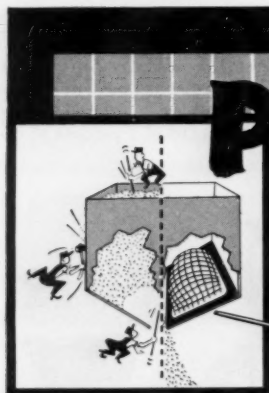
Assure constant material flow from your bins and hoppers with . . .

DEPENDABLE

SAFE

ECONOMICAL

QUIET



PneuBin Pulsating Panels

PneuBin is a new concept in material flow engineering. The PneuBin unit consists of steel-backed, neoprene, pulsating panels, strategically located on the inside walls of your present bins. Working off the plant's regular air supply, PneuBin is inflated and deflated in controlled cycles, causing the contents of the bin to be "positively displaced" and thus assures free flow of material through the discharge opening.

DEPENDABLE—PneuBin is on the job whatever the material flow problem. PneuBin's principle of "positive displacement" moves the bin contents, not the bin . . . assures constant, free-running material discharge. Depend on PneuBin to insure material flow.

SAFE—No manpower is needed to facilitate material flow from bins when PneuBin is on the job. No more prodding, poling or sledge-hammering. Depend on PneuBin to insure material flow . . . safely.

ECONOMICAL—PneuBin cuts maintenance costs, saves money year after year. Reduce bin damage . . . increase bin life. Depend on PneuBin to insure material flow . . . safely, economically.

QUIET—PneuBin pulsating panels breathe . . . not snore. No hammering or loud vibration noises. PneuBin's quiet operation adds to overall plant efficiency . . . reduces employee fatigue. Depend on PneuBin to insure material flow . . . safely, economically, quietly.

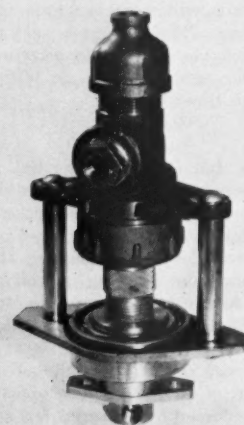
Send for "Flow Stoppage" and free literature. PneuBin engineers will gladly make recommendations with no obligation on your part.

PneuBin

A PRODUCT OF
GEROTOR MAY CORPORATION

1531 Maryland Ave., Baltimore 3, Maryland

Circle 13A on reply card

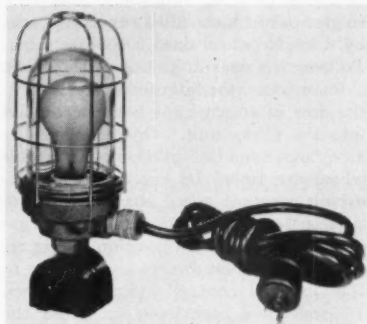


in case of run-out of any of the individual turning members. It is available with 1/4-inch and larger connections and can handle different media through the different passages at the same time. The joint is especially suitable for use on bottle filling and packaging machinery and on all types of machine tools where air or hydraulic cylinders have to be controlled during rotating or oscillating movements.

Circle 16E on reply card



The 100-watt electric lamp shown can be used with safety, it is claimed, in areas where dampness or vapor might cause a conventional bulb to explode but not where combustible gases are present. It incorporates a vaporproof fixture approved by Underwriters Laboratories and a base consisting of a permanent Neoprene-covered Alnico V magnet with



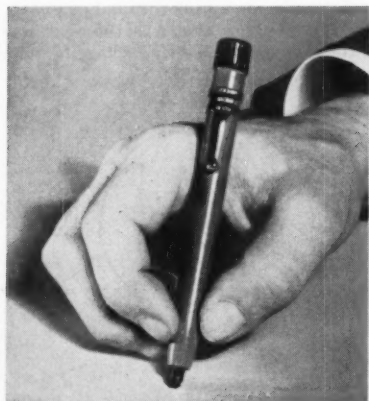
a 45-pound lift by which it can be positioned without delay on any ferrous metalwork. The 16-gauge, 3-conductor Neoprene cord is impervious to oils, most acids and chemicals, as well as to strong sunlight. The lamp is made by Standard Portable Cord Company, Inc., and is named Magic Vapor-Tite.

Circle 17E on reply card

It is reported that a new compound for marking off highway lanes that dries within 30 seconds after application outlasts paint or disks five to one. It is a plastic substance trade-named Veon and was tested in cooperation with the New York City Department of Traffic at Fifth Avenue and Forty-second Street, one of the world's busiest intersections.

Circle 18E on reply card

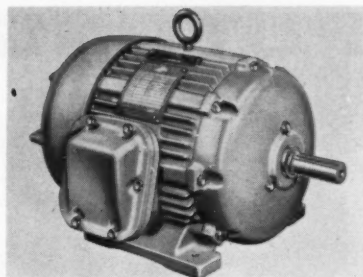
Of handy pocket size, Tweeten's new mechanical marking pencil is said to combine the qualities of crayons, paint sticks and soft-lead and grease pencils. It has a 5½-inch plastic barrel with a clip and screw top that feeds a 3½-inch refill available in black, white, red, blue,



green and yellow. According to the manufacturer, it is suitable for use on fabrics, paper, wood, rubber, plastic, glass, metal, stone and cement and leaves a legible mark on wet, dry, glossy, soft, coarse or painted surfaces.

Circle 19E on reply card

With Louis Allis Company's new line of explosion-proof electric motors, manufacturers can reduce the number carried in stock because in most cases a single unit will provide the necessary protection. Available in ratings of 1 to 25 hp 3-phase and 1 to 3 hp single-phase, they are labeled for convenience with Underwriters' approval for service in all Class I Group D and Class II



Groups E, F and G hazardous locations. A modification of the 3-phase motor has been cleared for installation in areas that come under the Class I Group C listing.

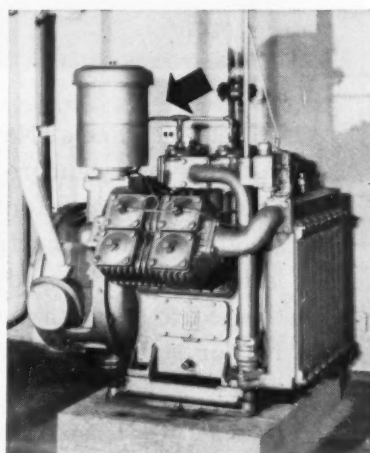
Circle 20E on reply card

Whether you build superhighways or inspect train brakes...

*Air-Maze filters will keep your
compressors on the go!*



THESE COMPRESSORS supplied air for wagon drills used on the new New York Thruway at Suffern, New York. Working in dust and dirt, these compressors need clean intake air to prevent serious breakdowns. That's why they're equipped with Air-Maze oil bath filters. These filters scrub intake air clean in a bath of oil, reduce engine overhaul costs, cut maintenance costs and down-time.



AT NEW ORLEANS union passenger terminal, this compressor supplies air for inspecting brakes on trains, operating pneumatic tools, paint spraying and other repair and maintenance jobs. Its Air-Maze oil bath filter keeps air-borne dirt from damaging polished pistons, valves, rings and other vital compressor parts. Specify Air-Maze filters on the compressors you build or buy.

AIR-MAZE The Filter Engineers

AIR FILTERS • SILENCERS • SPARK ARRESTERS
LIQUID FILTERS • OIL SEPARATORS • GREASE FILTERS

25000 Miles Road • Cleveland 28, Ohio

Circle 14A on reply card

PUTTING A ROAD IN ITS PLACE



This 18-inch line of Naylor Spiralweld pipe was installed to place more than 500,000 cubic yards of sand and gravel for a highway fill. The light weight of this distinctive pipe simplified installation at the new road level. At the same time, the extra strength and safety built into the Naylor structure assured the trouble-free delivery of the sand and gravel required.

For dredging, for high and low pressure air and water lines, for vent pipe and other construction services, Naylor offers the perfect combination with Naylor Spiralweld pipe and Naylor Wedge-Lock couplings. Write for Bulletin No. 507.



1245 East 92nd Street, Chicago 19, Illinois

Eastern U. S. and Foreign Sales Office: 350 Madison Avenue, New York 17, New York
Circle 15A on reply card

QUOTES

—FROM HERE AND THERE

Cans Go and Stop on Air Signal

"About every six seconds, 8 one pound cans are moved into and out of the filling machine used in one of the wax production lines at S. C. Johnson & Son, Inc. In groups of 15, the filled cans are placed by a loader wheel onto a cooling table. To keep the cans in groups of 15, an air cylinder operates intermittently to stop the flow of empty cans being screw fed into the filling unit. Operation of the air cylinder and the rotation of the loader wheel are timed by cams on a motor-driven constant speed shaft. One cam trips a 2-way pilot air valve to operate the main 4-way, two position spring return valve which directs air pressure to the 'interval control' cylinder. When 15 cans have been lined up under the loader wheel, the second cam engages to rotate the wheel and move the cans onto the cooling table."

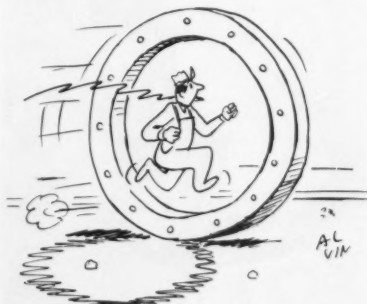
Applied Hydraulics, May 1955

Spray Method Solves Problem of Sterilizing Storage Tanks

"During the past seven years, use of liquid sugar by food processors has grown from mere occasional deliveries by single tank-trucks to substantial present-day hauls by large fleets of trucks and rail tank-cars. Today about 90% of all fruit canneries on the Pacific Coast employ liquid sugar in preference to the dry type . . .

"Handling of such large quantities has brought special problems in sanitation, such as cleaning and sterilizing of the storage tanks, which vary in size from modest 5,000-gal. units to 1,000,000-gal. giants used at C & H's (California & Hawaiian Sugar Refining Corp., Ltd.) Crockett, Calif., refinery . . .

"Sterilization of storage tanks always has been a time-consuming and very tedious job. Especially objectionable is the manual task of applying a chlorine solution inside a tank during hot weather. To eliminate this, a method has now been developed for using a fogging noz-



zle or spray. By merely hanging the nozzle in the tank's side manhole, disinfecting fog is diffused over interior surfaces without anyone needing to enter the tank.

"Effectiveness of this new method was checked by swabbing marked areas . . . with broth culture of viable yeast of known count. The tank was then sterilized and smears taken from the inoculated areas. Complete kills resulted in all instances. These tests were made on a 25,000-gal. tank at the C & H liquid-sugar tank farm in Los Angeles."

Food Engineering, March 1955

Man-made Diamonds

"Diamond, the hardest thing on earth, has finally been synthesized. Credit for the final stages of development belongs to scientists of the General Electric Research Laboratory, who have successfully made small diamond crystals, expensive even by diamond standards but of potential interest to industry. Even more important is that the frontier of science has been pushed farther back by this achievement."

Industrial Bulletin, Arthur D. Little, Inc., April 1955

Building Goes on in Winter Under Pliofilm Tent

"Warmth and light a-plenty during 13-deg temperatures was what Stan Llewellyn, Spokane masonry contractor, obtained for his men when he hit upon the idea of covering the two-story \$70,000 apartment house on which they were working with a Pliofilm tent which not only kept the cold air out and held in the hot air generated by the oil heaters, but also admitted the light necessary for carrying on the job.

"The Pliofilm to cover the front of the building and about half of each end cost Llewellyn only \$85. That was, he figured, about what he would have lost in pay if his crews had been laid off for 3



WILLIAM WALKER

JULY, 1955

THERE'S JUST NO END TO THE END USES OF CONTINENTAL RED SEAL® POWER

Within Continental's range, from two to 1,100 horsepower, it would be hard to name a type of engine-driven product—vehicle, aircraft, boat, or industrial machine—of which one or more of the leading makes do not rely today on Continental power. As might be assumed from the current trend toward greater specialization, the list of such applications is longer than ever before. The field of Red Seal usefulness has broadened to the point where—as this list suggests—there is almost no end to the industrial uses of dependable Continental power.

Air Compressors . . . Air Conditioners . . . Airplanes . . . Backfillers . . . Balers . . . Binders . . . Blowers . . . Buses . . . Bulldozers . . . Combines . . . Commercial Boats . . . Concrete Mixers and Pavers . . . Conveyors . . . Cranes . . . Crop Dusters . . . Derricks . . . Ditchers . . . Drill Rigs . . . Earth Borers . . . Earth Movers . . . Electric Welders . . . Elevators . . . Ensilage Cutters . . . Excavators . . . Farm Tractors . . . Gathering Pumps . . . Graders . . . Hay Loaders . . . Heavy Engine Starters . . . Helicopters . . . High Lifts . . . Hoists . . . Industrial Tractors . . . Irrigation Pumps . . . Loaders . . . Lumber Carriers . . . Materials Handlers . . . Oil Field Machinery . . . Parcel Delivery Trucks . . . Pile Drivers . . . Pipe Benders . . . Portable Generators . . . Rail Cars . . . Rollers . . . Rock Crushers . . . Saw Mills . . . Separators . . . Shovels . . . Snow Plows . . . Sprayers . . . Street Flushers . . . Street Sweepers . . . Threshers . . . Trainer Aircraft . . . Transit Mixers . . . Truck Tractors . . . Warehouse Trucks . . . Winches, and many others.

Continental also builds 4-cycle air-cooled models, from 2 to 3 h.p., for many industrial and farm applications, both conventional and vertical shaft. (AU series illustrated.) Advanced engineering gives them easy starting, high dependability, and unusual lugging capacity at low speeds. For information, address Air-Cooled Industrial Engine Div., 12800 Kercheval Ave., Detroit 15, Mich.



SERVICE FACILITIES AND GENUINE RED SEAL PARTS
ARE AVAILABLE EVERYWHERE

Continental Motors Corporation

MUSKOGON • MICHIGAN

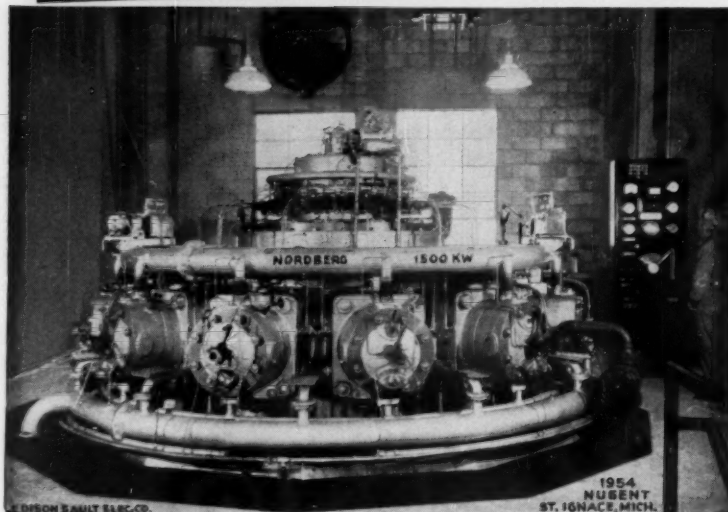
6 EAST 45TH ST., NEW YORK 17, NEW YORK • 3817 S. SANTA FE AVE., LOS ANGELES 58, CALIF.
6219 CEDAR SPRINGS ROAD, DALLAS 9, TEXAS • 910 S. BOSTON ST., ROOM 1008, TULSA, OKLA.
1252 OAKLEIGH DRIVE, EAST POINT (ATLANTA) GA.

Circle 16A on reply card

(219)

ADV. 19

Nugent filters selected as original equipment at St. Ignace power plant



Shown in the view above is a 1500 kw Nordberg Radial Diesel installed by the Edison Sault Electric Co. for municipal power service at St. Ignace, Michigan. Included as original equipment on this diesel was a Nugent Duplex Fuel Oil Filter of the type that removes 99.8% of all foreign solids from the fuel supply. The St. Ignace installation is still another example of Nugent filters being selected as original equipment by a leading diesel manufacturer.

Nugent filters are available in a wide range of sizes and types to meet every need. Size for size they provide 20 times more filtering area than any other filter. Full or by-pass filtering is possible with the same unit and simple piping makes installation easy. These are some of the reasons why leading diesel manufacturers specify Nugent filters as original equipment.

To assure longer life and better service from your own diesel, investigate the possibilities of Nugent filtering. Write today for complete information.



Wm. W. Nugent & Co., Inc.
422 N. Hermitage Ave. CHICAGO 22, ILLINOIS

OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS,
OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

Established
1897

Representatives in Boston • Cincinnati • Detroit • Houston • La Junta, Colo. • Los Angeles
Minneapolis • New Orleans • New York • Philadelphia • Portland, Ore. • San Francisco
Seattle • St. Louis • Tulsa • Representatives in Canada: Montreal • Toronto • Vancouver



Nugent duplex fuel oil filter of the type used on the new diesel at St. Ignace. Bag type recharges are inexpensive and simple to replace.

hours. He got the idea for a plastic transparent covering after experimenting with tarpaulins which kept the heat in, but admitted no light."

Construction Methods and Equipment,
March 1955

Vaporizing Rust Inhibitors

"The latest approach to rust prevention is the use of 'vapor phase inhibitors,' so called because of their method of application. These are organic chemicals that, when released into a confined space, evaporate slowly, depositing the active rust-inhibiting agent on the surfaces to be protected. So far, only a few products in this class are available commercially, but this concept of corrosion control has received increasing acceptance in recent years. Greatest industrial use has been in packaging ferrous metal spare parts."

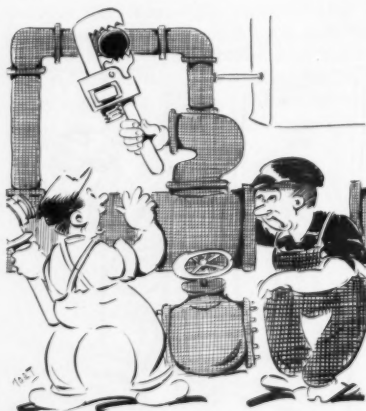
Industrial Bulletin, Arthur D. Little, Inc., April 1955

Laboratory Installs Compressor Plant To Test Airplane Equipment

"One of the largest air facilities has been installed at Wyle Laboratories. Located at El Segundo, California, the facilities are available to the entire aircraft industry for economical development and qualification test work.

"This new facility consists of a two-stage compressor driven by an 820 horsepower electric synchronous motor. The compressor has a continuous capacity air flow of 200 pounds per minute at a pressure of 250 psi. Entire output of this system is heated in a natural gas-fired heat exchanger to temperatures of approximately 1000 degrees F. Flows of approximately 12 pounds per second can be achieved under transient conditions for cycling of valves, pressure regulators, turbines and other hot air driven airborne accessory equipment."

Applied Hydraulics, March 1955



"One more turn, Mike."

Industrial Literature

Compressed Air Power is the title of a sound-color motion picture produced under the auspices of the Educational Committee of Compressed Air and Gas Institute primarily as an engineering teaching aid. By means of animation and different shades of blue (pale blue for vacuum, brighter blue for atmosphere and deep blue for compressed air) it enables the novice to follow and comprehend the compression cycle of each of the different types of compressors, as well as the operating principles involved in the various ways compressed air is applied. The picture begins with a graphic presentation of the simplest form of compressor—the bicycle pump—and continues on through from a single-acting machine driven by a crank and fly-wheel to displacement and dynamic compressors, including centrifugal and axial-flow units. It shows the effect of cooling to dissipate heat of compression and ends with an animated explanation of compressed-air power as applied to linear action, air hammer, agitation of liquids, pressurizing, atomizing and operating motors. The 16-mm, 17-minute film can be obtained from the Institute, 1410 Terminal Tower, Cleveland, Ohio, at a cost of \$60 per projection print.

Illustrated Bulletin No. 2486 describes types, sizes and load characteristics of Blaw-Knox Company's complete line of electroforged steel and interlocked aluminum gratings.

Circle 21E on reply card

Bulletin No. 433 released by Acheson Colloids Company contains information, illustrations and charts on "dag" colloidal graphite and its application in the electronic and electrical industries.

Circle 22E on reply card

Trico Fuse Manufacturing Company has released an illustrated condensed catalogue—No. 55—which contains full information on all its electrical and lubricating devices.

Circle 23E on reply card

Miniature air cylinders, valves, manifolds and fittings, originally designed and manufactured by Clippard Instrument Laboratory, Inc., for its own use and now generally available, are the subject of a 4-page illustrated folder.

Circle 24E on reply card

Miller Fluid Power Company describes its double-acting reciprocating boosters in a 4-page folder which includes line drawings of varying circuits for single- and double-acting cylinders and gives mounting data.

Circle 25E on reply card

Catalogue 5002 is a new edition of Minneapolis-Honeywell Regulator Company's composite booklet on its principal types of industrial instruments and equipment. A reference to more detailed literature accompanies each item.

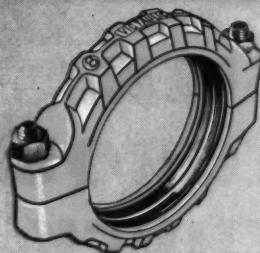
Circle 26E on reply card

Air Reduction Sales Company has issued a new publication catalogue which lists more than 100 technical cutting and welding reprints, text and safety books, slide films and motion pictures available for the most part without cost.

Circle 27E on reply card

Air Power Package is the title of an 8-page booklet recently released by Ingersoll-Rand Company. It tells all about the company's Spot-Air compressor, a self-contained unit that two men can carry or lift onto a small truck or one worker can push around on a

VICTAULIC METHOD OF PIPING



VICTAULIC COUPLINGS

Styles 77, 77-D for standard applications. Simple, fast to install—sturdy and reliable. Sizes $\frac{3}{4}$ " to 30". Style 75 Light-Weight Couplings for light duty applications. Sizes 2", 3", 4". Additional styles for cast iron, plastic and other pipes. Sizes through 60".



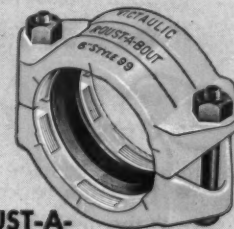
VICTAULIC FULL-FLOW FITTINGS

Complete line of Elbows, Tees, Reducers, Laterals, etc.—to fit all Victaulic Couplings. Streamlined for top efficiency, easy to install. Sizes $\frac{3}{4}$ " to 12".



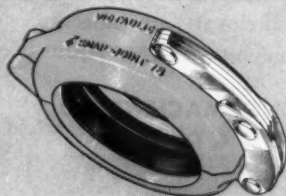
VIC-GROOVER TOOLS

Handy, on-the-job grooving tools that do the work in half the time. Light weight, easy to handle—operate manually or from any power drive. Automatic groove position and depth. Sizes $\frac{3}{4}$ " to 8".



ROUST-A- BOUT COUPLINGS

Style 99 for plain or beveled end pipe. Best engineered, most useful plain end joint on the market. Simple, husky—easy and fast to install. Takes strong bull-dog grip on pipe. Sizes 2" to 8".



VICTAULIC SNAP-JOINTS

Victaulic's new boltless, speed coupling. — Style 78 — hinged into one assembly. Hand-locks for time and dollar savings. Sizes 1", 1 $\frac{1}{4}$ ", 2", 3", 4".

EASIEST WAY TO MAKE ENDS MEET

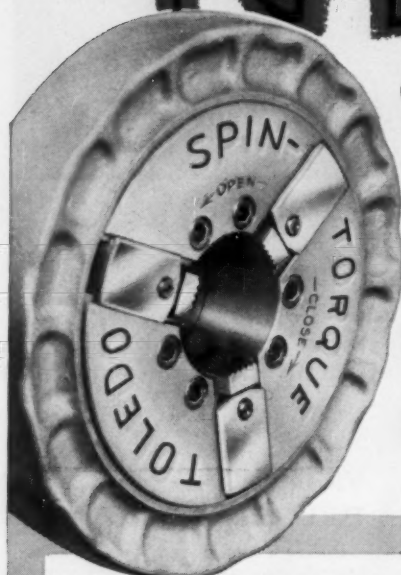
Promptly available from distributor stocks coast-to-coast. Write for NEW Victaulic Catalog-Manual 55-7B

VICTAULIC
COMPANY OF AMERICA
P. O. Box 509 • Elizabeth, N. J.

Circle 18A on reply card

It's Terrific . . .

the **NEW**



SPIN TORQUE CHUCK

**The Perfected Chuck-
Locks Tight with a
*Spin of the handwheel!***

● No more rocking, socking or hammering with the new "TOLEDO" SPIN TORQUE CHUCK. Now you can chuck $\frac{1}{8}$ " to 2" pipe, or rod as small as $\frac{1}{4}$ ", with a spin of the handwheel. Jaws are flush with chuck—exclusive rocking wedge action of jaws prevents slipping — husky "big hand" grip on wheel is easier to tighten — no end thrust slippage. See them at your pipe tool suppliers, now. Next time try "TOLEDO".

THE TOLEDO PIPE THREADING MACHINE CO.
1445 SUMMIT ST., TOLEDO 4, OHIO

BUILDERS OF THE WORLD'S FINEST PIPE TOOLS
TOLEDO[®]
PIPE THREADERS • PIPE WRENCHES • PIPE MACHINES

Circle 19A on reply card

wheelbarrow mounting. The 36-cfm gasoline-powered machine is fully described, together with the many tools it can operate. The publication contains numerous on-the-job illustrations.

Circle 28E on reply card

The Industrial Finishes Division of E.I. du Pont de Nemours & Company is offering two technical bulletins which describe its dip-tank and flow-coat finishing processes in detail and discuss their advantages and disadvantages.

Circle 29E on reply card

Jergens Tool Specialty Company has available a general catalogue (No. 101) on its line of work-holding equipment and jig and fixture components. Of 64 pages, it includes engineering data on thousands of stocked sizes of chuck-jaw blanks, handles, knobs, wheels, clamp assemblies, etc., as an aid to designers, engineers, production supervisors and the like.

Circle 30E on reply card

New information on how to increase the service life of carbide tools and to reduce tool cost is contained in the eighth edition of the *Carmet Methods Manual* published by the Carmet Division of Allegheny Ludlum Steel Corporation. The company's new steel-cutting grades CA-608 and CA-610 are also discussed. They are said to offer superior crater resistance.

Circle 31E on reply card

Solving Roof Problems is the title of a brochure released by The Tremco Manufacturing Company for the use of those concerned with industrial roof maintenance. Based on both laboratory research and field experience, the 32-page book discusses the various types of roofs, the factors that enter into their deterioration, and how to repair them.

Circle 32E on reply card

Wheelco Instruments Division of Barber-Colman Company is offering Educational Bulletin No. 9 especially to engineers confronted with the problem of selecting automatic control equipment to meet specific process requirements. In addition to technical data, operational diagrams and schematic drawings, the 16-page book gives detailed information on saturable core reactor control for electric loads.

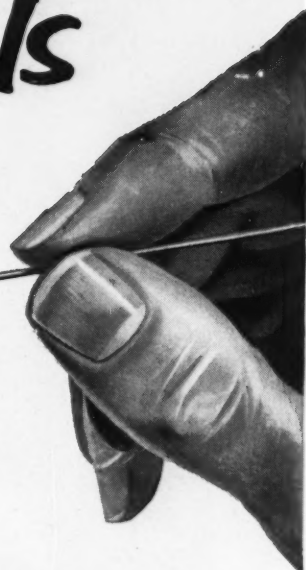
Circle 33E on reply card

The manufacture of carbide is shown in a 16-mm sound and color film released by National Carbide Company, a Division of Air Reduction Company, Inc. Called *Fiery Magic* because of the blazing electric furnaces in which coke and lime are combined to form calcium carbide, the picture also portrays one of its products, acetylene, and



„Beer always gives him the hiccups.”

A New PM TOOL for Diesels



SAVE Time, Money, Oil and Engines with the Shell ADC* Oilprint Analysis

Now—operators can test crankcase oil in the short time allotted for re-fueling and oil level checks. The Shell ADC Oilprint Analysis gives a practical and accurate oil evaluation in minutes.

ADC Oilprint Analysis means big savings when used in your preventive maintenance program . . . gives valuable information on engine and oil conditions. It answers the question "When do I change my oil?" thus eliminating the draining of usable oil and the risk of using oils loaded with contaminants.

See for yourself how the new Shell ADC Oilprint Analysis can save you real money in preventive maintenance.

*Trademark

*Let us demonstrate how you
can use this Service for Your Diesels*



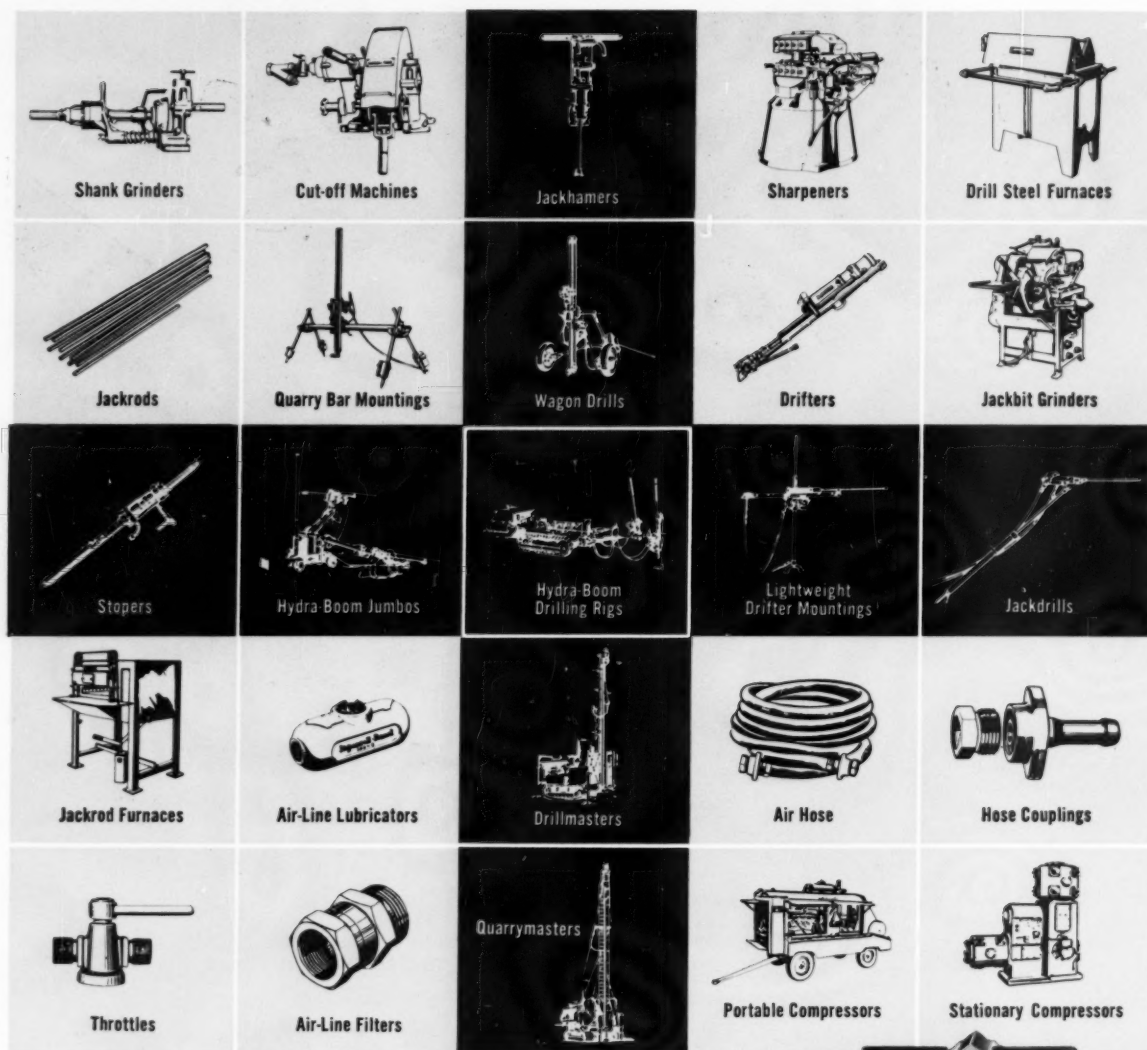
VEHICLE NO. _____ MAKE _____
OIL TYPE _____ OIL _____
TOTAL MILES _____
FREQUENCY OF OIL CHANGES _____

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the big **PLUS VALUE**

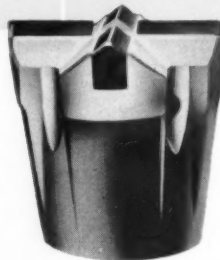


behind every I-R **CARSET JACKBIT**

You can't drill rock with a *bit* alone. But behind every Ingersoll-Rand Carset Jackbit there's a COMPLETE LINE of rock drilling equipment.

Whatever you need for drilling rock — from the bit all the way back to the compressor — you can be sure that Ingersoll-Rand can help you. From one source with undivided responsibility you get a coordinated line of equipment that's designed and built to work together. You get complete *service*, too — backed by over 80 years of experience and leadership in the rock drilling field.

That's a big *plus* in your favor when you make Ingersoll-Rand your headquarters for everything in rock drilling.



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15-232

ROCK DRILLS • COMPRESSORS • AIR TOOLS • TURBO BLOWERS
CONDENSERS • PUMPS • OIL & GAS ENGINES

its uses first in lamps and now in welding and cutting and as a base in chemical processes. The 23-minute film may be borrowed for showing from district offices of Air Reduction Sales Company, from National Carbide outlets or directly from National Carbide Company, 60 E. 42nd Street, New York 17, N.Y.

New York & New Jersey Lubricant Company is offering Bulletin 506 on the lubrication and maintenance of ball and roller bearings. It includes helpful do's and don'ts to prolong their life and information on the storage and handling of lubricants.

Circle 34E on reply card

Annually since 1929, the Eastern Railroad Presidents Conference has published the *Yearbook of Railroad Information*. The 1955 pocket-size edition is now available. Of 100 pages and well indexed, it is a valuable reference work on United States railroad operations as a whole.

Circle 35E on reply card

General Electric Company's Specialty Control Department is distributing Bulletin GEA-6234 which describes and illustrates its general-purpose full-wave Thy-mo-trol adjustable-speed drive with printed control circuit. The unit converts a-c to d-c power by the use of electron tubes and is said to be economical to operate.

Circle 36E on reply card

In a 32-page manual Crucible Steel Company of America has condensed all the data users of fine stainless-steel wire need to help them select the proper type to meet given specifications. It deals with its Rezistal, of which there are three classifications—*austenitic, ferritic and martensitic*—each of which is fully discussed. The book also lists their common uses and typical end products and contains information on finishes, corrosion, spools and coils.

Circle 37E on reply card

Finishes for Alcoa Aluminum is the title of a 48-page book which describes their basic characteristics, their methods and means of application and illustrates the many ways in which the beauty of the metal can be enhanced by color in the full spectrum range. In conclusion, Alcoa outlines its research and development services available to customers, designers and architects who want to adapt the finishes to their needs. Copies of the publication may be obtained by written request on company letterheads to Aluminum Company of America, 762 Alcoa Building, Pittsburgh 19, Pa.



"J.B. . . . I'm afraid we're in a rut."

JULY, 1955

Circle 21A on reply card

Accurately made, Superior quality

**GARLOCK
O-RINGS**



Now stocked at all Garlock Branch Warehouses

CONTACT THE GARLOCK BRANCH NEAREST YOU

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Hamilton, Ont.	Vancouver, B. C.
Montreal, Que.	Winnipeg, Man.

Yes, now you can obtain Garlock O-Rings direct from our branch warehouse nearest you. Each of our warehouses stocks 70 durometer rubber O-Rings in all popular standard sizes. For you this reduces delivery time to a minimum.

You can rely on Garlock O-Rings, too. They're made to Garlock's rigid quality standards. This means O-Rings with precise tolerances, a flash-free finish, and utmost uniformity.

For complete information, just contact your Garlock office or write for new O-Ring folder AD-148.

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

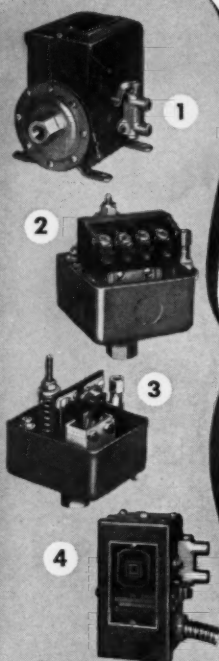
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.



GARLOCK

Circle 22A on reply card

Adv. 25



SQUARE D

FOR A Complete Line OF H.P. RATED AIR COMPRESSOR SWITCHES

- ① Heavy Duty
 - ② Standard Duty
 - ③ Gas Engine Cut-Out
 - ④ Magnetic Unloader
- full range of electrical
and pressure ratings

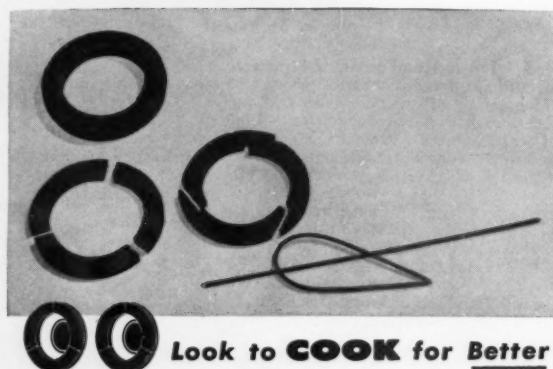
Write for Bulletin 550,
Square D Company, 4041 North
Richards St., Milwaukee 12, Wis.

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS



SQUARE D COMPANY

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MATERIALS

GRAPHITIC IRON
(Exclusive with Cook)

COOKMET
(No. 1—Plastic Bronze)
(No. 2—Semi-Plastic Bronze)
(No. 3—Alloy Bronze)

BABBITT
(Highly Anti-Frictional)

COOKROC
(Laminated Bakelite: Standard,
Hi-Temp and Graphitized)

CARBON
(For Non-Lubricated Service)

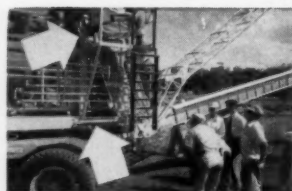
**C. LEE
COOK
COMPANY**

Sealing Pressures Since 1888

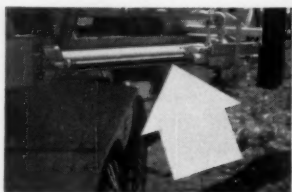
Whatever your packing-ring requirements, you can depend on Cook for a ring design and ring material that will deliver maximum efficiency at minimum cost.

One source, one high standard of quality—that's what you get when you specify Cook—packing-ring pioneers since 1888. Write direct for complete technical data. C. Lee Cook Manufacturing Co., 930 So. 8th St., Louisville 8, Ky.

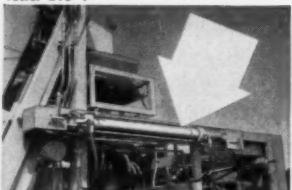
Circle 24A on reply card



Arrows show location of 2 Nopak Cylinders.



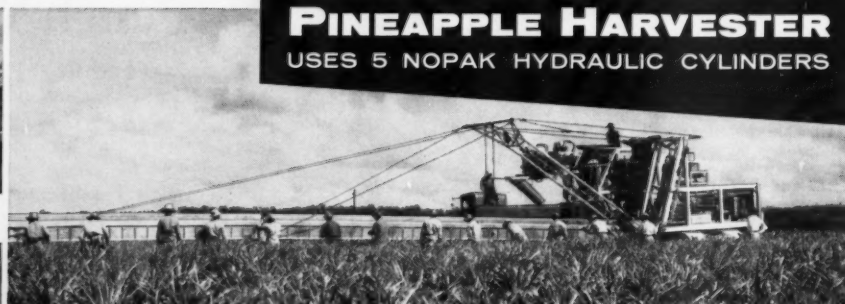
Close-up view of Nopak Cylinder which rotates superstructure of harvester 210°.



Nopak 4" x 48" cylinder positions conveyor boom to suit field conditions.

*With the cooperation of Nopak Hawaiian representative, Chapson Bros. Ltd., Honolulu.

PINEAPPLE HARVESTER USES 5 NOPAK HYDRAULIC CYLINDERS



Unique Machine Developed in Hawaii by Libby, McNeil & Libby Engineers*

The pineapple harvester pictured is the result of continuing research and experimentation by the mechanical engineering staff of Libby, McNeil and Libby, in striving for better methods, more efficient machines, and lower costs in all operations from field and farm to packing and labeling.

While space does not permit a detailed description of their functions . . . 5 Nopak Hydraulic Cylinders are used in this self-

contained harvester to provide the power for various movements essential to its successful operation.

Power for machine motions . . . pulling, pushing, lifting, feeding, retracting . . . are provided in all kinds of machinery and equipment by Nopak Cylinders . . . controlled by Nopak Operating Valves. For a wide range of interesting installations, write for the Nopak APPLICATION MANUAL.

GALLAND-HENNING NOPAK DIVISION
2759 SOUTH 31ST STREET • MILWAUKEE 46, WISCONSIN

Refer to Classified Section of your Telephone Directory for name of nearest Nopak Representative.

Ask for Nopak Cylinder Catalog 101 or Bulletin SW-3.

NOPAK
® VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

A 8388-1/2 HA



BEARIUM METAL superiority proved in over 25 years of "on-the-job" service in scores of varied applications.



Special castings made to customer's specifications.



Wherever there is a bearing application involving high speeds, poor lubrication, heat-generating loads, elevated temperatures, dusty and gritty surroundings—or where a liquid other than oil is used as a lubricant—there you will find the ideal application for **BEARIUM METAL**. For it is under adverse operating conditions such as these that **BEARIUM METAL** out-performs all other types of bearing materials . . . by prolonging bearing life, preventing shaft seizure and scoring. In short, it does a more efficient job longer at lower operating cost.

We'll be glad to send you the complete story on **BEARIUM METAL**, so write **TODAY!**

BEARIUM METALS CORP.

270 State St., Rochester 14, N. Y.

WEST COAST AFFILIATE:
Nevin Engineering Associates
932 Chautauqua Blvd.
Pacific Palisades, Calif.

IN CANADA:
Bearium Metals of Canada, Ltd.
155 George St.
Toronto 2, Canada

Circle 26A on reply card

**STOP THAT NOISE
STOP THAT NOISE
STOP THAT NOISE
IRK!**

**with
BURGESS-MANNING
SNUBBERS**

Stop all noises from air, steam or other gases discharged into the atmosphere. In fact, Burgess-Manning Snubbers can be engineered to both intake or exhaust noise problems and for use in closed systems to arrest surges and eliminate pipeline vibration.

Burgess-Manning Snubbers may also include such added features as: spark arresting — or air cleaning — or water separating — or heat recovery — or surge control, etc.

Let us recommend to you. Write for details stating your problem.

BURGESS-MANNING COMPANY

Sound Engineering 57 East Park Avenue, Libertyville, Illinois
Dallas, Texas



DEPENDABLE PNEUMATIC SERVICE



WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTAINED UNIT



DriAir may be installed by suspending it from the piping, without any other support, or may stand on the floor near equipment being protected.

DRIAIR speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request.

**NEW JERSEY
METER COMPANY**
PLAINFIELD, NEW JERSEY

COMPRESSOR FACTS ON INDUSTRY'S
MOST PREFERRED "POWER PACKAGE"



FACT: The new Life-Line A is the most weather-resistant motor on the market

Whether your application is hot—cold—wet or dry, you'll find the new Westinghouse Life-Line® "A" motor will last longer under more extreme weather conditions than any other motor you can buy.

New insulation materials, housing designs, 4-way sealed bearings are tangible evidence of electrical, mechanical and lubrication system improvements that make Life-Line "A" industry's most preferred package of power.

Westinghouse builds a complete line of motors from 1 to 700 hp for compressor applications everywhere. Get all the facts by calling your Westinghouse sales engineer . . . *The Man With The Facts.*

J-21903

YOU CAN BE **SURE**... IF IT'S
Westinghouse





Dresser-Ideco Co. designed and fabricated the steelwork for this greatest of the TV giants; Mizell Construction Co., Ganado, Tex., handled the erection.

Wire Rope at Work—The tallest structure ever built by man now pokes its spire through the Oklahoma clouds, rising like a giant steel needle from the surrounding plains. This is the television tower of Station KWTW, Oklahoma City—a landmark that measures 1572 ft from ground level to top.

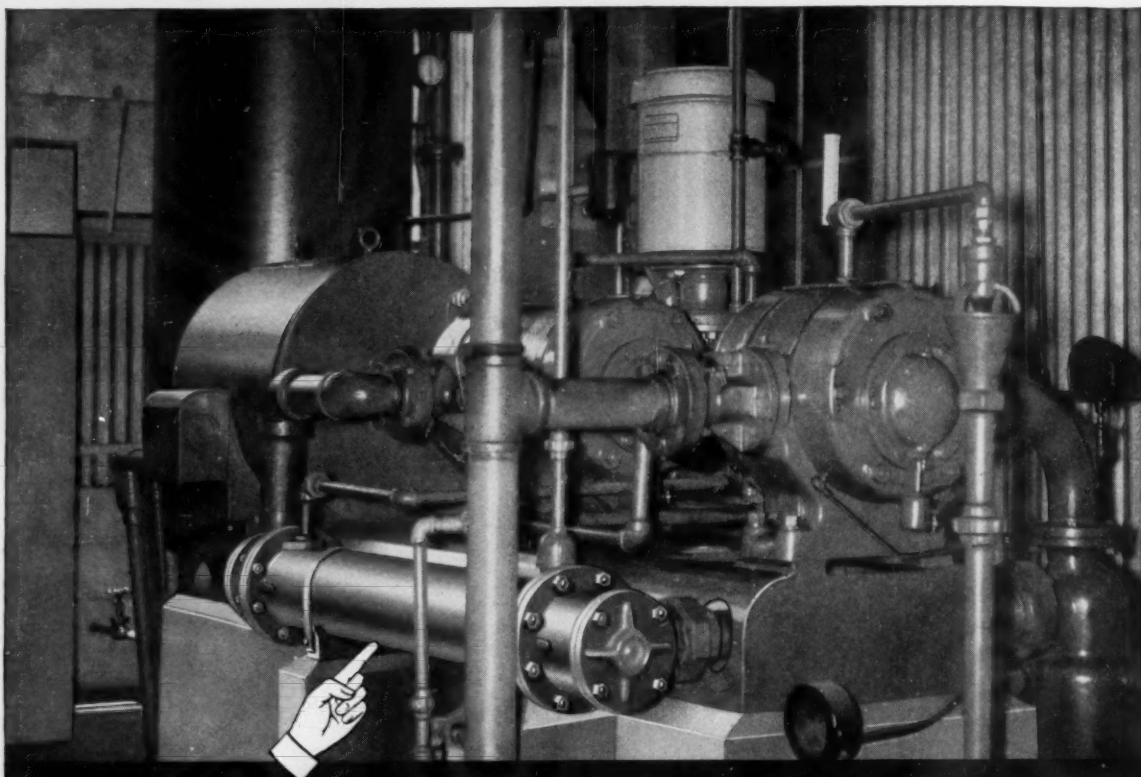
So slim and graceful is the tower that, from a distance, it appears to be a delicate line penciled against the sky. Yet it weighs 1,323,392 lb—a vertical load that requires the sturdiest type of bracing. To guy the structure, the engineers employed 24 steel cables composed of Bethlehem strand, a member of the Bethlehem wire rope family. These tremendously strong guy lines, which range in diameter from 1½ to 2 in., have an aggregate weight of more than a hundred tons and a combined length of over five miles.

Bethlehem Steel Company, Bethlehem, Pa. On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Mill depots and distributors from coast to coast stock Bethlehem rope for the following industries and numerous others:

CONSTRUCTION • MINING • PETROLEUM • EXCAVATING • QUARRYING • LOGGING • MANUFACTURING





ROSS INTERCOOLER increases thru-put capacity of this two-stage compressor

With a capacity of 347 cfm at 100 psi, this rotary, two-stage air compressor is equipped with a Ross Intercooler. First stage heat of compression and excess moisture are thus removed, with minimum pressure loss. Result: greater thru-put capacity.

Because of their high heat exchange efficiency and extreme ruggedness, Ross Intercoolers, Aftercoolers, Lube Oil Coolers and Jacket Water Coolers are widely preferred by compressor builders and users.

Another reason: Kewanee-Ross *Standardization*. A broad range of designs and sizes are readily available to answer most needs without unnecessary "specials" in engineering and fabrication.

Detailed information will be furnished promptly on request. Write for Bulletin 0.4A7.



**AFTERCOOLERS
INTERCOOLERS
LUBE OIL COOLERS
JACKET WATER COOLERS**

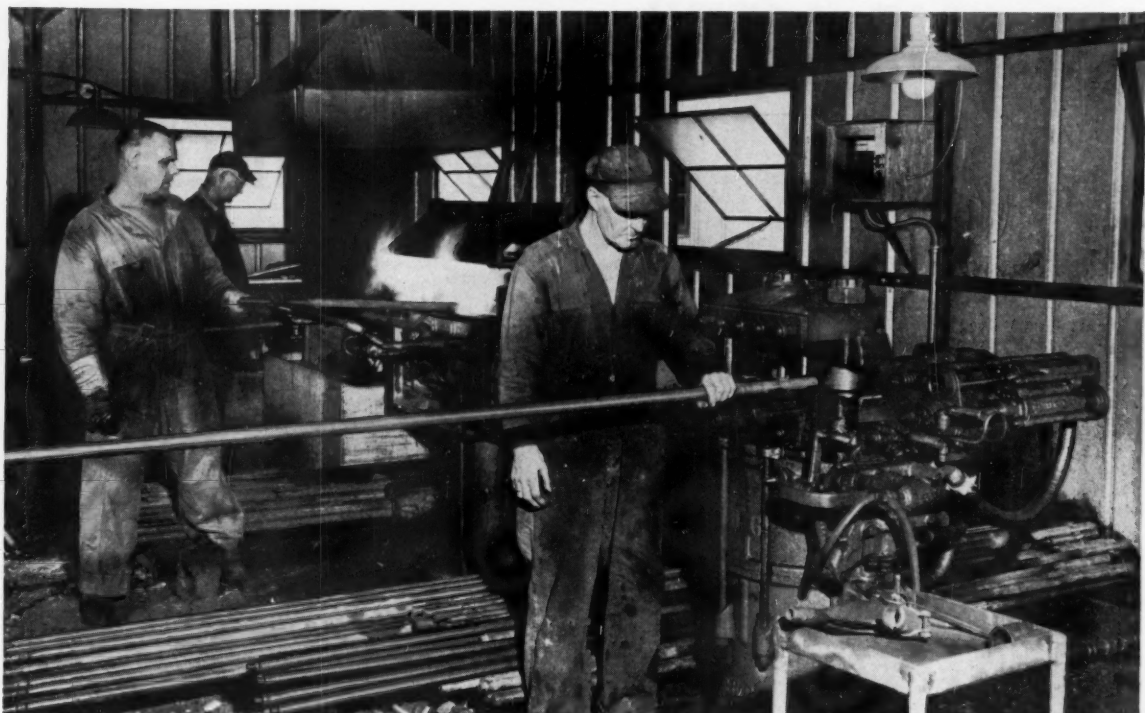


KEWANEE-ROSS CORPORATION

DIVISION OF AMERICAN RADIATOR & STANDARD SANITARY CORPORATION

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Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS



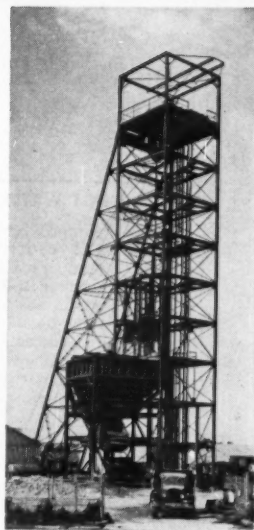
Blacksmith Billy Watkins shanking a Crucible Hollow Drill Rod.

they're using Crucible Hollow Drill Rods on the Boston Tunnel Jobs . . .

400-feet below the city of Boston, two seven-mile tunnels are being cut through solid rock. Replacing century-old mains, the tunnels will bring water from Quabbin Reservoir, 70 miles away, and remove drainage from the city.

On this job, like most other tough ones, Crucible Hollow Drill Rods are in daily use. For experienced construction men *know* they can depend upon Crucible Hollow Drill Rods for top performance at *lowest cost per foot of hole drilled*.

That's because they are made to *tool steel* standards by the nation's leading producer of *special steels*. So for *extra* dependability on *all* your drilling jobs specify Crucible Hollow Drill Rods. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 30, Pa.*



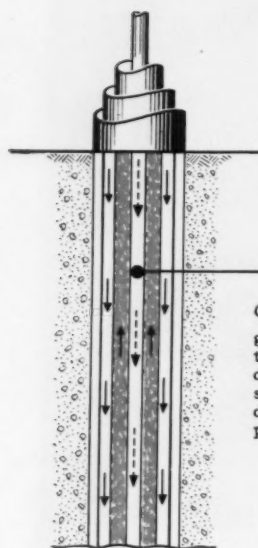
120-foot-high head frame used to raise and lower men and materials in excavation shaft. Morrison-Knudsen-Kiewit-Maney City Tunnel Extension Job, Boston, Mass.

CRUCIBLE

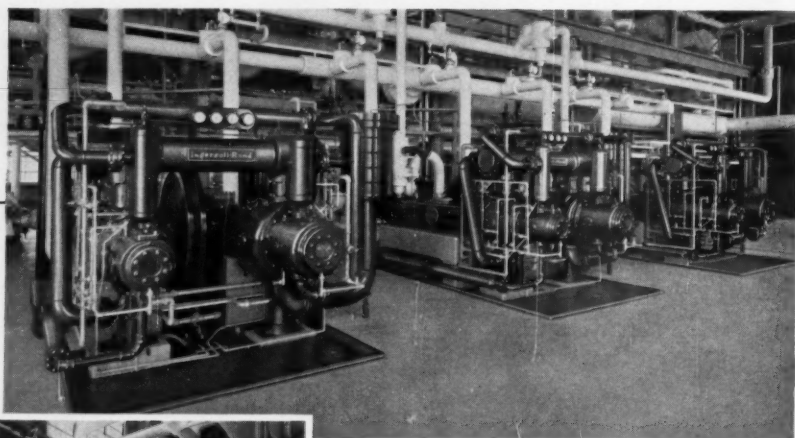
first name in special purpose steels

Crucible Steel Company of America

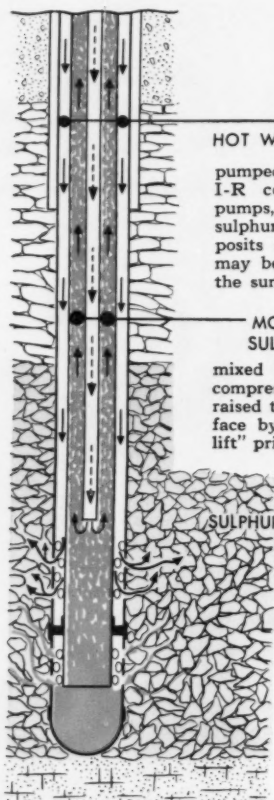
I-R "AIR LIFT" raises sulphur at SPINDLETOP



COMPRESSED AIR generated by these I-R steam-driven compressors, is forced down the center pipe at 600 psi.



Newest plant of Texas Gulf Sulphur Company mines molten brimstone with Ingersoll-Rand air and water power



HOT WATER, pumped by these I-R centrifugal pumps, melts the sulphur in the deposits so that it may be lifted to the surface.

MOLTEN SULPHUR, mixed with the compressed air, is raised to the surface by the "air lift" principle.

SULPHUR DEPOSIT

Here at the Spindletop mine of the Texas Gulf Sulphur Company, near Beaumont, Texas, a huge underground deposit containing thousands of tons of sulphur is being brought to the surface in liquid form by the modified Frasch process illustrated at the left. The only mining "tools" are air and hot water. Compressed air forced down the center pipe mixes with the melted sulphur and raises it to the surface by what is in effect an "air lift".

Once started, this operation never stops. Hence the *dependability* of Ingersoll-Rand equipment is particularly important. Power for the "air lift" is provided by the Ingersoll-Rand Type XPV 4-stage steam-driven compressors shown above. And hot water is pumped into the wells to melt the sulphur by a battery of I-R Type JVL centrifugal pumps.

This is another example of how I-R equipment is serving vital industries the world over. Ingersoll-Rand compressors are built in sizes from $\frac{1}{2}$ to 4,000 hp, for pressures ranging from vacuums to 22,000 psi — with any type of drive. Whatever your compression problem, your nearest I-R engineer has the answer.

Ingersoll-Rand

1-255 11 BROADWAY, NEW YORK 6, N. Y.



COMPRESSORS • PUMPS • AIR AND ELECTRICAL TOOLS • VACUUM EQUIPMENT • ROCK DRILLS • CONDENSERS • GAS AND DIESEL ENGINES

The USS Forrestal—

another example of how Walworth helps protect
a 200 million dollar investment

Walworth products installed aboard the *USS Forrestal* include gate, globe, and lubricated plug valves and pipe fittings. They are used on high pressure air lines, fire mains, and most of the other piping systems throughout the ship.

Thousands of Walseal® Bronze Valves, Fittings, Flanges, and Unions comprise the major portion of the Walworth installations.

Walseal is a registered trade mark which identifies valves and fittings manufactured by the Walworth Company. Walseal products have *factory-inserted rings* of silver brazing alloy in threadless ports. Walseal joints can be made only with Walseal valves and fittings.

WALWORTH

valves . . . pipe fittings . . . pipe wrenches

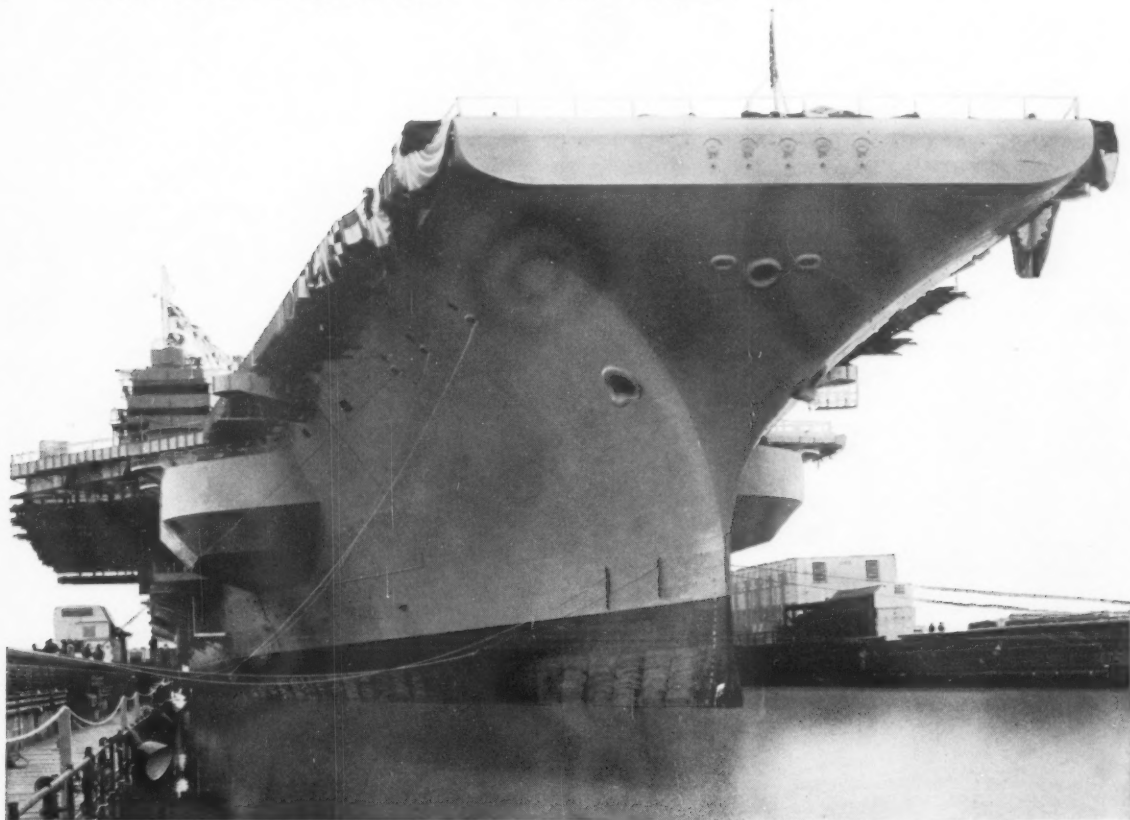
60 East 42nd Street, New York 17, N. Y.
Walworth Company of Canada, Ltd., Toronto

Keel laying to launching—Walworth was there.

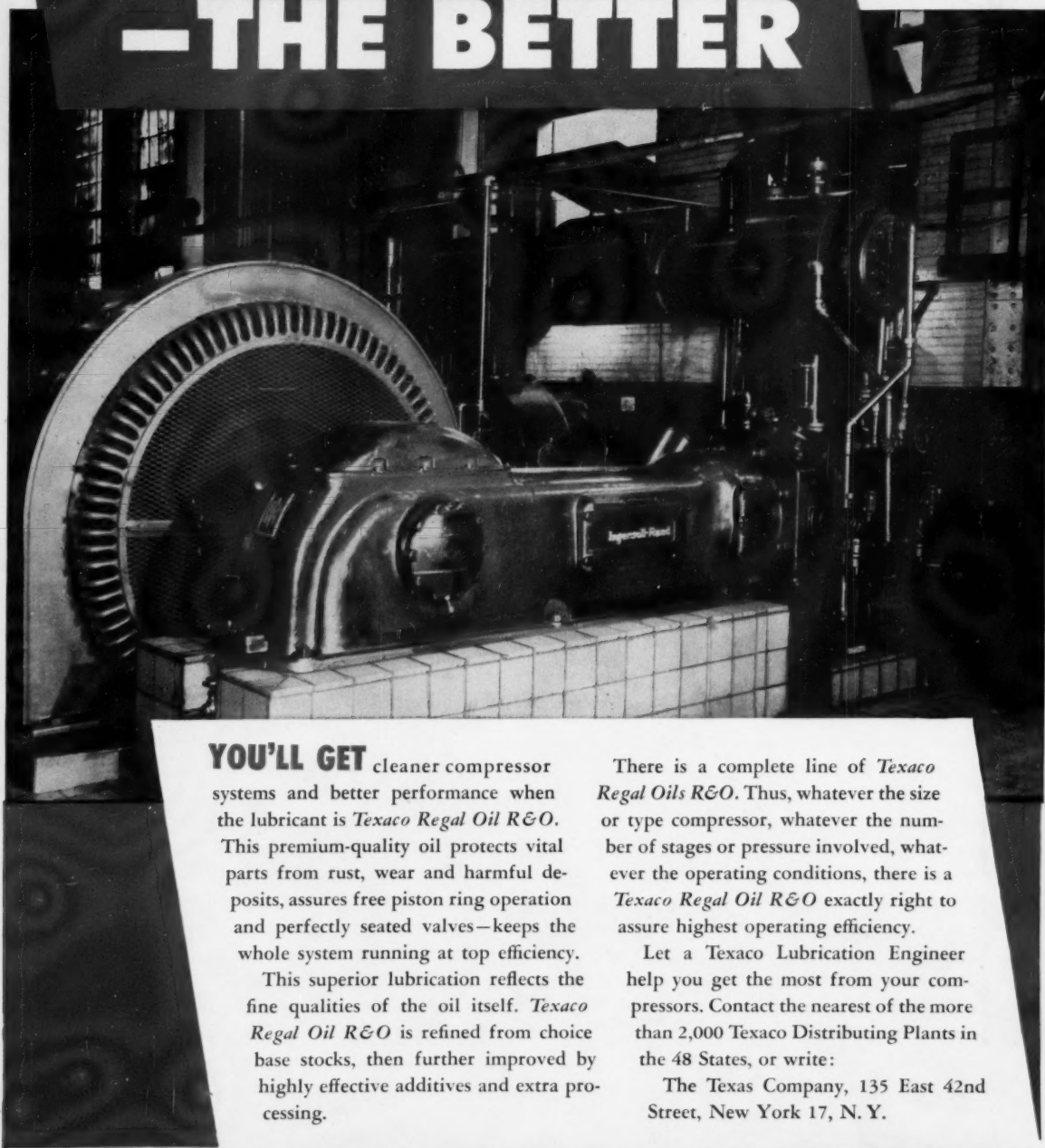
Walworth engineers worked with designers, metallurgists and builders of the mighty flat-top right from the blueprint stage. Their efforts assured the builder—Newport News Shipbuilding and Dry Dock Company—that *every* Walworth Valve and Fitting installed would meet *every* specification right down to the finest detail.

The *Forrestal*—like the *USS Nautilus*, the first nuclear-powered submarine—is another striking example of where Walworth engineering and products were called upon to protect a multimillion dollar investment.

Walworth, backed by 113 years of practical valve experience, is skilled in every type of installation. Whatever the industry, if your problem concerns valves or fittings, it will pay you to call on Walworth! Distributors in principal cities throughout the world.



THE CLEANER —THE BETTER



YOU'LL GET cleaner compressor systems and better performance when the lubricant is *Texaco Regal Oil R&O*. This premium-quality oil protects vital parts from rust, wear and harmful deposits, assures free piston ring operation and perfectly seated valves—keeps the whole system running at top efficiency.

This superior lubrication reflects the fine qualities of the oil itself. *Texaco Regal Oil R&O* is refined from choice base stocks, then further improved by highly effective additives and extra processing.

There is a complete line of *Texaco Regal Oils R&O*. Thus, whatever the size or type compressor, whatever the number of stages or pressure involved, whatever the operating conditions, there is a *Texaco Regal Oil R&O* exactly right to assure highest operating efficiency.

Let a Texaco Lubrication Engineer help you get the most from your compressors. Contact the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.



TEXACO Regal Oils R & O

FOR ALL AIR COMPRESSORS AND OPERATING CONDITIONS

TUNE IN . . . TEXACO STAR THEATER starring DONALD O'CONNOR or JIMMY DURANTE on television . . . Saturday nights, NBC.

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